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PROCEEDINGS

OF THE

AUSTRALASIAN

Institute of Mining Engineers.

NEW SERIES.

No. 25.

EDITED BY THE SECRETARY.

This Institute is not responsible, as a body, for the facts and opinions advanced in any of its publications.

31st MARCH, 1917.

PUBLISHED QUARTERLY BY THE AUSTRALASIAN INSTITUTE OF MINING ENGINEERS, MELBOURNE.

Australasian Institute of Mining Engineers.

LIST OF OFFICERS, 1917.

President:

R. S. Black, W.A.

Vice-Presidents:

W. E. Wainwright, N.S.W. | D. B. Waters, Dunedin, N.Z.

R. W. Chapman, S.A.

Councillors:

E. G. Banks	New Zealand
W. H. Corbould	Queensland
C. F. Courtney	New South Wales
H. Lipson Hancock	South Australia
H. Herman	Victoria
E. W. Skeats	Victoria
John W. Moule	Queensland
G. D. Delprat	New South Wales
Richard Hamilton	Western Australia
A. S. Kenyon	Victoria
Geo. H. Broome	Victoria
George Weir	New South Wales
George C. Klug	Western Australia
A. A. Boyd	Queensland
James Hebbard	New South Wales
James Horsburgh	Queensland
F. Danvers Power	New South Wales
Lindesay C. Clark	Tasmania
H. H. Schlapp	Victoria
Robert C. Sticht	Tasmania

Secretary:

D. L. Stirling, Melbourne, Vic.

Local Correspondents:

South Australia	Professor R. W. Chapman, Adelaide.
New South Wales	F. Danvers Power, Sydney.
New Zealand	D. B. Waters, Dunedin.
Tasmania	Russell M. Murray, Mount Lyell.
North Queensland	Murray Russell, Cloncurry.

Branch Secretaries:

Kalgoorlie	F. W. R. Godden, Ivanhoe Gold Corporation, Boulder, W.A.
Broken Hill	J. M. Bridge, c/o Zinc Corporation Ltd., Broken Hill, N.S.W.
Mount Morgan	B. G. Patterson, Mount Morgan, Q.

The Executive Committee consists of all Members of the Council residing, or for the time being, in Melbourne.

Head Office:

57-59 Swanston Street, Melbourne, Victoria.

Institute Matters.

CONTENTS.

	Page
MINUTES OF MEETINGS—	
Of the Institute	
Annual Meeting—1917	iii
Report of Council—1916	iv
Balance Sheet	ix
Of the Council	xii
Of the Executive Committee	xii
NOTICES	xiii
PUBLICATIONS—Added to Library	xv
RECENT ARTICLES—On Mining Matters	xviii
LIST OF MEMBERS—Names and Addresses	xxi

MINUTES OF MEETINGS.

OF THE INSTITUTE.

ANNUAL MEETING.

MELBOURNE, 26TH JANUARY, 1917.

IN THE INSTITUTE ROOMS, 57-59 SWANSTON STREET, AT 1 P.M.

Mr. A. S. Kenyon occupied the chair.

The Secretary read the notice convening the meeting.

Minutes of the Annual Meeting, 1916, were confirmed.

The report of the Council and Balance Sheet for 1916, were read and adopted.

It was resolved that it be a suggestion to the Council that space be reserved in the Proceedings, free of charge, regarding employment desired; that a page be reserved for Members' pro-

fessional card advertisements, for which a fee would be charged, and that a paragraph be inserted concerning movements of Members.

The result of the ballot for the election of officers to fill the vacancies was reported as follows :—

President -	R. S. Black. W.A.
Vice-President -	R. W. Chapman, S.A.
Council - -	A. A. Boyd. Q.
	Lindesay C. Clark, Tas.
	James Hebbard, N.S.W.
	James Horsburgh, Q.
	F. Danvers Powers, N.S.W.
	H. H. Schlapp, Vic.
	Robt. C. Sticht, Tas.

The meeting then closed.

Report of the Council for 1916.

TO THE MEMBERS.

The Council has pleasure in submitting herewith a report of the Proceedings of the Institute for the year 1916.

The number of Members on the Register is now 602, made up as follows :—Honorary Member, 1 ; Life Members, 5 ; Members, 387 ; Associate Members, 143 ; Students, 64 ; Subscribers, 2.

Twenty-nine Members resigned during the year and Forty-eight were removed from the register for non-payment of subscriptions. Three Members were admitted to the Institute. The net loss was therefore 74.

By the death of Mr. Henry Rosales, which occurred on 3rd June, the Institute lost its oldest Member. Mr. Rosales was 96 years of age. He was born in Spain and educated in France and Germany. Coming to Victoria in the early fifties he followed his profession

first at Ballarat and Clunes. He afterwards became manager of the Walhalla Gold Mining Co. He was a Fellow of the Institute and took a keen interest in its affairs.

The names of Members killed at the war are reported elsewhere.

Mr. A. A. Boyd of Mount Morgan, was elected to fill a vacancy on the Council.

Owing to the war the First Ordinary Meeting for 1916 was cancelled and the only meeting held was the Annual Meeting on 28th January.

A suggestion to hold the First Ordinary Meeting for 1917, in Western Australia, coincident with the opening of the East-West Railway, is under consideration and an announcement thereon will shortly be made. It has also been proposed that a series of lectures on " Metals and the War " be arranged for during the year.

Publications issued during the year were :—Proceedings (new series) Nos. 20, 21, 22 and 23. In common with other Institutes the number of papers published during the year has been less than in former years, as it was considered that the income from subscriptions would be affected on account of the war. A considerable sum has thus been placed in reserve and it is hoped that during the coming year the income from subscriptions will justify an increase in the volume of Proceedings.

Satisfactory progress was made during the year in the matter of Institute representation on Boards and Faculties controlling mining education. In some instances, owing to the constitution of the Faculty or Board, direct Institute representation could not be obtained ; but in most of these cases the governing body already included one or more Members of the Institute. It is felt that this movement will materially benefit mining education and tend to keep the engineering courses in touch with practical requirements.

A committee was recently formed to promote the co-ordination of the Universities and Technical Mining Schools with mining and allied sciences. In this connection a scheme has been drawn up by a committee representing a number of the principal mining companies for the encouragement of suitable candidates who intend

adopting the professions of mining-engineering and metallurgy. The Institute is represented on this committee by Professor E. W. Skeats (Member of Council).

The Federal Institute of Science and Industry was constituted early in the year and the important section of metallurgy is represented by Messrs. G. D. Delprat (Member of Council), and J. M. Higgins.

In conjunction with other Institutes objection was lodged to the proposed registration of a body assuming the title of "The Australian Union of Architects, Engineers, Surveyors and allied Professions." Registration of the proposed association was eventually refused by the Registrar.

The Council was represented at a conference on Australian timbers and reafforestation held in Melbourne in November. It is to be hoped that the work of the conference will contribute considerably to the problem of developing one of the richest and most neglected of the natural resources of Australia.

Prior to the departure for the front of the first Australian mining corps a considerable sum of money was collected for band instruments for the corps by Mr. Peter Sutherland of Melbourne. The donors were the various mining companies and at their request the presentation was made through the Institute. The ceremony took place at Broadmeadows in February in the presence of several Members of Council. Mr. James Hebbard (Member of Council) made the presentation which was acknowledged by Colonel Fewtrell, the officer commanding the corps.

On several occasions the attention of the Institute has been directed to the matter of reports on mining properties by unqualified men. The mining industry, the investing public, and the status of the mining engineer has suffered considerably on this account. Prospectuses containing reports by self-styled mining engineers, with a special gift for making the proposition alluring, without much regard to facts, have from time to time being issued, with the inevitable result. The Council has under consideration certain suggestions which should go a long way towards remedying this evil.

The Institute has reason to be proud of the response made by its Members to the call to join the colors. The list on Active Service now includes:—

Aarons, J Boyd
Adcock, Garnet I.
Alexander, Hubert
Anderson, E. S.
Anderson, W. T.
Avery, Wm. P.
Bayly, Colin (Killed in Action)
Banks, C. A.
Barber, C. S.
Bennet, V. C.
Berriman, R. V.
Best, G. H. T.
Bell, W. G.
Bell, J. Mackintosh
Bloom, Leo
Blunden, L. E.
Bray, F. P.
Brown, H. Wheeler
Bullen, G. L.
Burbidge, Percy
Campbell, A. G.
Casey, R. G.
Carroll, H. H.
Connor, J. L. (Killed in Action)
Coulter, Leslie J. (D.S.O.)
Cowles, Richard
Clayton, C. H. T.
Dempster, G. C.
Donaldson, R. J.
Dow, J.
Dunstan, Basil
Foxall, J. S.
Fraser, E. H.
Fraser, D. L.
Finlayson, R. J. Stanley
Gabriel, G. E.
Goode, K. B.
Grut, L. de Jersey
Hargraves, E. L.
Hammel, H. E.
Herbertson, R. C.
Holder, E. M.
Hooper, F. H.
Horsley, Ralf D.
Hunter, Stanley B. (Member of Council)
Hughes, Eric W.
Irvine, C. L.
Jowett, A. C.
Kelly, M. B. H.
Key, J. F.
Kneebone, C. S.
Lakeland, Wm. J.
Lewis, Keith B.
Marks, D. G.
Mawdsley, W. H.
Marryatt, Cyril S.
MacDonnell, W. H. A.
MacKenzie, D. C.
M'Bryde, Jas. (Killed in Action)
Mickle, K. A.
Moore, R. I.
Morris, A. C.
Mulligan, E. N.
Moore, K. Byron
M'Callum, N. S. Kellie
M'Padden, J. C.
Nicholas, Frank H. (Military Medal)
Pearson, H F.

Peat, James
Pethebridge, H. S.
Roberts, R. A. J.
Rose, W. J.
Rutherford, A. R.
Rutherford, T. W. L.
Rae, Cecil
Sayer, W. T. (Killed in Action)
Seale, H. V.
Smith, R. S.
Smith, W. F.
Smith, E.
Southon, R. D.
Sweet, O. G.
Tandy, A. E.
Townsend, H.
Tucker, V.
Turner, W. A.
Veitch, Neil A.
Wallmann, H. P.
Waters, Professor D. B. (Vice-President)
Watts, R. T. (Killed in Action)
Wentworth, D'Arcy
Weigall, H. S.
Williams, O. B.
Wilkins, Lawrence G.
Woodward, O. H. (Military Cross)

Several Members have gained honors for conspicuous service; viz:—Major Leslie J. Coulter (awarded D.S.O.), Frank H. Nicholas (awarded military medal), O. H. Woodward (awarded military cross).

In addition to those reported killed in action during 1915 the following have made the great sacrifice, viz:—James M'Bryde and W. T. Sayer. The former was a Lieutenant in the 1st Field Coy. of Engineers, A.I.F. and was killed in action in the battle of the Somme on 13th September, 1916. W. T. Sayers was a 2nd Lieutenant in the Royal Engineers and was killed during 1916 The Council tenders its sincere sympathy to the relatives of the brave dead.

In common with kindred bodies the Institute has suffered on account of the war and the Council earnestly invites Members to do all they can during the coming year in the direction of enrolling new Members. A special obligation rests with everyone to maintain the strength of the Institute whilst so many Members are serving the Empire on the battlefield and it is hoped that when the war is over Members returning from the front will find that the status and strength of the Institute have not been lowered.

AUSTRALASIAN INSTITUTE OF MINING ENGINEERS.

Balance Sheet, 31st December, 1916.

LIABILITIES.

Subscriptions paid in advance			£7	17	6
Accumulated Fund—					
Balance at 31st Dec., 1915	£539	6 3			
Add Surplus transferred from Revenue A/c ...	411	0 10			
			950	7	1
			£958	4	7

ASSETS.

Cash on Hand	£2	2	0			
State Savings Bank at credit	269	5	9			
Commonwealth Savings Bank at credit	43	18	4			
				£315	6	1
Commonwealth of Australia War Loan ...				425	0	0
Outstanding Subscriptions, 1915	20	11	6			
,, ,, 1916	145	18	4			
				166	9	10
Sundry Debtors for Advertisements	19	0	0			
Suspense Account — Cash in hands of New Zealand Branch	2	16	3*			
				21	16	3
Office Furniture, Melbourne and Broken Hill Branch ...	33	16	11			
Less Depreciation	4	4	6			
				29	12	5
				£958	4	7

* This Amount has been refunded.

Melbourne, 25th January, 1917. Audited and found correct. B. H. Oxlade, A.C.P.A., Auditor.

Statement of Receipts and Expenditure for the Year ended 31st December, 1916.

RECEIPTS.

To Bank of Australasia, Balance at Credit ...		£67	18	11		
State Savings Bank ...		9	11	10		
					£77	10	9
Members' Subs., 1910 ...		2	2	0		
,, ,, 1911 ...		2	2	0		
,, ,, 1913 ...		1	11	6		
,, ,, 1914 ...		29	0	0		
,, ,, 1915 ...		108	18	6		
,, ,, 1916 ...		737	10	3		
,, ,, 1917 ...		7	17	6		
					889	1	9
Advertisments	...	...			47	10	0
Sales	...	...			18	12	1
Interest	...	...			31	9	6
Entrance Fees	...	...			9	10	0
Fixed Deposit repaid ...	...	...			200	0	0
					£1273	14	1

EXPENDITURE.

By Postages, Telegrams, &c.	£32	14	3			
Printing & Stationery ...	14	13	6			
Salaries	277	0	0			
Rent	48	0	0			
Sundries	27	13	3			
				£400	1	0
Branches				50	0	0
Proceedings				314	6	0
Commission				9	1	0
Donation—Mining Comforts Fund ...				10	0	0
Commonwealth of Australia War Loan				175	0	0
Commonwealth Savings Bank	43	18	4			
State Savings Bank ...	269	5	9			
Cash on Hand	2	2	0			
				315	6	1
				£1273	14	1

Revenue Account for the Year ended 31st December, 1916.

1916.						1916.					
Dec. 31.	To Publications	£149	9	0		Dec. 31.	By Subs., 1910 ...	£ 2	2	0	
	Branches ...	50	0	0			,, 1911 ...	2	2	0	
	Stationery & Printing ...	11	9	0			,, 1913 ...	1	11	6	
	Postages ...	32	14	3			,, 1914 ...	8	0	0	
	Salaries ...	256	0	0			,, 1916 ...	906	3	1	
	Rent ...	48	0	0							919 18 7
	Sundries ...	27	13	3			Advertisements and Sales ...				62 7 1
	Commission	9	1	0			Interest				17 16 2
	Donation—Mining Comforts Fund	10	0	0			Entrance Fees				9 10 0
					£594 6 6						
	Depreciation (Furniture) ...				4 4 6						
	Surplus for year transferred to Accumulated Fund ...				411 0 10						
					£1009 11 10						£1009 11 10

Melbourne, 25*th January*, 1917. Audited and found correct. B. H. Oxlade, A.C.P.A., *Auditor*.

Of the Council.

February 26th, 1917—1 p.m.

It was resolved that an Executive Committee, consisting of Members of the Council resident, or, for the time being in Melbourne be appointed for 1917.

Of the Executive Committee.

(Summary).

Feburary, 26th, 1917—1.15 p.m.

The Secretary's report was presented and accounts to the amount of £75 were passed for payment.

Nomination of Mr. Alex. Downe was submitted and held over for further consideration.

Resignations of Messrs. H. A. Gordon, W. P. Gauvain, George Kelly, and R. Eades were accepted.

Sub-Committees were appointed for 1917.

Draft of paragraph re signatures to prospectuses, recommended for insertion in the proposed Federal Companies Act, was submitted and approved.

A paper on Tests of Explosives was submitted and it was decided that publication thereof be deferred.

Resolved that no excursion be held in connection with the First Ordinary meeting, 1917.

Other routine business was transacted.

NOTICES.

The rooms of the Institute are open from 9.30 A.M. to 10 P.M. daily, except Sundays and Public Holidays.

MEMBERSHIP.

Application for admission to the Institute as a Member has been received from Mr. Gilbert Rigg, Collins House, Melbourne, and for admission as Associate Member from Mr. Harry J. Myles, Inspector of Mines, Cloncurry, North Q.; whose names are herewith submitted to Members for confidential report.

The following were admitted to the Institute on 26th February :—

MEMBERS.

NAMES AND ADDRESSES.

IMANAGA, T., Müke, Japan.
SCOBLE, EDWARD JOHN, Kikuranga, Whangarei, N.Z.

ASSOCIATE MEMBERS.

RYAN, DENIS L., Fremantle Trading Co., Fremantle, W.A.
STEVENSON, GODFREY, Stannary Hills, North Q.
TURNER, TOM H., 73 Ormond Esplanade, Elwood.

ON ACTIVE SERVICE.

The following have notified their enlistment since the issue of the December Proceedings :—

CARLESS, NOEL	GRIEVE, W. H.
CLELAND, W. LAUDER	MILLETT, BERT
DUBOIS, A. J.	SHAW, J. B.
GARTRELL, H. W.	TWINE, G. J.

Honor Won.

Lieut. G. Escott Gabriel has been awarded the military medal.

FIRST ORDINARY MEETING, 1917.

Owing to the war it has been decided that no excursion be held in connection with the First Ordinary Meeting, 1917, and that the meeting be held at the head office to comply with the rules when purely formal business will be transacted.

SIGNATURES TO PROSPECTUSES.

A draft of paragraph dealing with signatures to prospectuses by qualified engineers has been approved by the Council and recommended for insertion in the proposed Federal Companies Act.

MOVEMENTS OF MEMBERS.

It has been decided that space be reserved in the Proceedings for information regarding movements of Members and it is requested that Members notify the Secretary of any notes of interest concerning themselves or other Members.

POSITIONS VACANT.

The Council has decided to inaugurate an employment exchange on behalf of Members. Mining companies will be requested to keep the Institute advised regarding positions vacant, and members are requested to forward to the Secretary particulars of qualifications (i.e. training, positions held, etc.) making special mention of any branch of Mining engineering upon which they have specialized. These particulars will be filed for reference.

PROFESSIONAL CARDS.

Space will be reserved in the Proceedings for the insertion of Members' Professional Cards at the rate of 5s. for one insertion, or 10s. per year (four insertions).

LIST OF PUBLICATIONS ADDED TO THE LIBRARY

From 31st December, 1916, to 31st March, 1917.

Australian Mining Standard	weekly	Melbourne
Australian Mining and Engineering Review	monthly	Melbourne
Engineering and Mining Journal	weekly	New York
Iron and Coal Trades Review	weekly	London
Mining Journal	weekly	London
Mining and Scientific Press	weekly	San Francisco
The Colliery Engineer	monthly	Scranton, Pa.
Mining and Engineering World	weekly	Chicago
Mining Magazine	monthly	London
Indian Engineering	weekly	Calcutta
Chemical News	weekly	London
South African Engineering	monthly	London
Journal of Industrial and Engineering Chemistry	monthly	Easton, Pa.
Society of Chemical Industry : Journal	bi-monthly	London
Chemical, Metallurgical and Mining Society of South Africa : Journal	monthly	Johannesburg
Franklin Institute : Journal	bi-monthly	Philadelphia
Institution of Mechanical Engineers : Journal	monthly	London
Metallurgical and Chemical Engineering	monthly	New York
Chamber of Mines of Victoria : Monthly Mining Report		Melbourne
Chamber of Mines of Western Australia : Journal	monthly	Kalgoorlie
The West Australian Mining, Building and Engineering Journal	weekly	Perth
Queensland Department of Mines : Government Mining Journal	monthly	Brisbane
Transvaal Chamber of Mines : Monthly Analysis of Production		Johannesburg
Rhodesia Chamber of Mines : Report of Executive	monthly	Bulawayo
Department of Mines, Victoria : Memoir No. 13		Melbourne

Australian Museum :	
Report of Trustees for 1915 - - -	Sydney
Northern Engineering Institute of New South Wales :	
Papers, 2nd and 13th September, 1916 -	Newcastle
Department of Mines, Queensland :	
Geological Survey, Publication, No. 250 -	Brisbane
Department of Mines, South Australia :	
Annual Report of the Government Geologist for 1915	Adelaide
Department of Chemistry, South Australia :	
Bulletins, Nos., 2 and 4 - - -	Adelaide
Royal Society of South Australia :	
Transactions and Proceedings, Vol. XL. -	Adelaide
Department of Mines, Tasmania :	
Geological Survey, Bulletin, No. 25 - -	Hobart
Royal Society of Tasmania :	
Papers and Proceedings, 1916 - -	Hobart
Department of Mines, New Zealand :	
Mines Statements for 1915 - - -	Wellington
Geologists' Association :	
Proceedings, Vol. XXVII., Parts 3 and 4 -	London
Institution of Mining and Metallurgy :	
Bulletins, Nos. 146-149 - - -	London
Institute of Chemistry of Great Britain and Ireland :	
Proceedings, 1916, Part IV. - - -	London
Geological Society :	
Quarterly Journal, Vol. LXXI., No. 284 -	London
Institution of Mining Engineers :	
Transactions, Vol. LII., Parts 1 and 2 -	London
Mining and Geological Institute of India :	
Transactions, Vol. X., Part 2 - -	Calcutta
Geological Survey of India :	
Records, Vol. XLVII., Part 3 - -	Calcutta
Société Des Ingenieurs Civils De France :	
Proceedings, 1916, Nos. 11 and 12	
Mémoires, Nos. 7-11, 1916 - - -	Paris
Annales des Mines :	
Vol. V., 1916 - - - -	Paris
Nova Scotian Institute of Science :	
Proceedings and Transactions, Vol. XIV., Part 2	Halifax

American Institute of Mining Engineers :
Bulletins, Nos. 120-122 - - - New York
University of California :
Bulletin, No. 6 - - - - Berkeley
United States Geological Survey :
Professional Papers, Nos. 89, 98 A-98 H
Water Supply Papers, Nos. 332, 369, 374, 375 G, 383, 398 and 399
Bulletins, Nos. 610, 618, 619, 620 O, 621 E, 621 M, 621 P, 623, 626, 628, 629, 632-634, 640 A, 640 C and 641 A
Mineral Resources, Various Papers - - Washington
Smithsonian Institute :
Annual Report, 1915 - - - Washington
Field Museum of Natural History :
Geological Series, Vol. III., No. 10 - - Chicago

SUBSCRIPTIONS.

☞ Members are reminded that Subscriptions for 1917 are due, and are requested to forward same as early as possible.

RECENT ARTICLES ON MINING MATTERS.

(31st December, 1916, to 31st March, 1917).

NOTE.—*This list is prepared for the purpose of placing before members the titles of the more important papers appearing in the usual publications concerned with mining engineering, metallurgy, &c., due regard being had to Australasian requirements.*

LIST OF PUBLICATIONS.

References are given by the number prefixed to each publication in the attached list. Wk., weekly; mth., monthly.

(1) *The Australian Mining Standard*, Melbourne, Victoria, wk., 6d.

(2) *The Queensland Government Mining Journal*, Brisbane, mth., 6d.

(3) *Metallurgical and Chemical Engineering*, New York, mth., 25c.

(4) *The Mining Journal*, London, E.C., wk. 6d.

(5) *Mining and Engineering World*, Chicago, wk., 10c.

(6) *The Engineering and Mining Journal*, New York, wk., 15c.

(7) *The Colliery Engineer*, Scranton, Pa., U.S.A., mth., 20c.

(8) *Mining and Scientific Press*, San Francisco, Cal., wk., 10c.

(9) *Annales des Mines*, Paris, France, mth.

(10) *Publications*, Department of Mines, Melbourne, Victoria.

(11) *Publications*, Department of Mines, Sydney, New South Wales.

(12) *Publications*, Department of Mines, Adelaide, South Australia.

(13) *Publications*, Department of Mines, Brisbane, Queensland.

(14) *Publications*, Department of Mines, Perth, Western Australia.

(15) *Publications*, Department of Mines, Hobart, Tasmania.

(16) *Publications*, Geological Survey, Canada, Ottawa, Ontario.

(17) *Publications*, Bureau of Mines, Toronto, Ontario.

(18) *Publications*, Geological Survey of India. Calcutta.

(19) *Publications*, Geological Survey, U.S.A., Washington.

(20) *Publications*, Geological Survey, Alabama, Montgomery, Ala.

(21) *Publications*, California State Mining Bureau, Sacramento, Cal.

(22) *Reports* Aust. Assoc. Adv. Science Sydney, New South Wales.

(23) *Transactions and Proceedings*, New Zealand Inst., Wellington, New Zealand.

(24) *Quarterly Journal*, Geological Society, London.

(25) *Transactions*, Inst. Mining and Metallurgy, London, E.C.

(26) *Transactions*, Inst. Min. Eng., London.

(27) *Journal*, Canadian Mining Inst., Ottawa Ontario.

(28) *Journal*, Chem., Min., and Met. Soc. of S.A., Johannesburg, Transvaal.

(29) *Transactions*, Am. Inst. of Min. Eng. New York City.

(30) *Proceedings*, Colorado Scientific Soc. Denver, Col.

(31) *Journal*, Franklin Inst., Philadelphia, Pa.

(32) *Australian Mining and Engineering Review*, Melbourne, Vic., mth., 6d.

(33) *Transactions*, Am. Soc. C.E., New York City.

(34) *Bulletins*, Société des Ingénieurs Civils, Paris.

(35) *Mining Magazine*, 819 Salisbury House London, E.C., mth., 1s.

(36) *Publications*, Iron and Steel Institute London.

(37) *Proceedings*, Inst. of Mech. Eng., London.

(38) *Publications*, Field Columbian Museum Chicago, U.S.A.

(39) *Journal*, Mining Society of Nova Scotia, Halifax, N.S.

(40) *Transactions*, Mining and Geological Institute of India, Calcutta.

(41) *Publications*, Department of Mines, Wellington, N.Z.

(42) *Journal*, Chamber of Mines of West Australia, Perth.

(43) *Journal of Industrial and Engineering Chemistry*, Easton, Pa.

(44) *Proceedings*, Geologists' Association, London.

LIST OF ARTICLES.

MECHANICAL.

The Utilization of Waste Heat for Steam Generating Purposes. A. D. Pratt. (3) Serial commenced Dec. 15. 1916.
Efficiency of Compressed Air Installations. T. Simons. (6) Serial commenced Dec. 16, 1916.
Launder Flotation Machine. B. M. Snyder. (6) Dec. 16. 1916.
Chart for Determining Heat Loss in Flue Gases. (6) Dec. 23, 1916.
The Wave-Transmission System and its Use in Drilling. E. M. Weston. (6) Dec. 30, 1916.
The Seasoning of Castings. R. Moldenke. (29) Feb., 1917.
Portable Miners' Lamps. E. M. Chance. (29) Feb., 1917.

METALLURGICAL.

Outlines for the Determination of Zinc. R. Franklin Heath. (5) Dec. 16, 1916.
Sulphuric Acid from Copper Smelting Gases. E. L. Larison. (6) Dec. 30. 1916.
Electrolytic Refining at Trail. T. A. Rickard. (8) Dec. 23, 1916.
Flotation in 1916. (8) Jan. 6. 1917.
Vaporization of Metallic Copper in Wirebar Furnaces. A. Butts. (3) Jan. 15, 1917.
The Calculation of Lead Blast Furnace Charges for Students of Metallurgy. B. Dudley. (3) Serial commenced Jan. 15. 1917.
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MINING.

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Centimetres, cm. ; cubic centimetres, cc.; metres, m.
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Square inches, etc , sq. in.; cubic inches, etc., cub. in.
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Horse power, h.p.; indicated horse power, i.h.p.; brake horse power, b.h.p.
Candle power, c.p.
British thermal units. B.Th.U.
High pressure, H.P. ; low pressure, L.P.
Ampere, amp.; kilowatts, kw.
Percentages, %; degrees, °; specific gravity, sp. gr.
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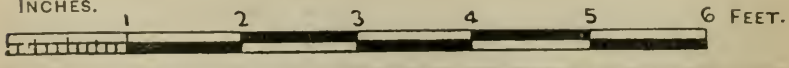

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* Fellow. † Honorary member. ¶ Life member. F Foundation member.

§ Author of paper.

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Adam, John, Gt. Fingall Mine, Day Dawn, W.A.	1910
Adams, Ernest F., Box 5, P.O., Thames, N.Z.	1900
Adams, James Henry, Thames, N.Z.	1911
Agnew, John A., 1 London Wall Buildings, London, E.C. ..	1909
§Allen, Francis Bowen, Director Technical Education, Perth, W.A.	1900
Anderson, Charles A., "Elna," Central Park-road, East Malvern, Vic.	1904
Anderson, J. R. V., School of Mines, Bendigo, Vic. ..	1910
§Aplin, Wm., Mt. Morgan Technical College, Mt. Morgan, Q. ..	1905
Armstrong, Andrew S., Aurora West United, G.M. Co., Maraisburg, *via* Johannesburg, South Africa ..	1912
Ashcroft, J. W., c/o R. N. Kirk, 16 O'Connell-street, Sydney, N.S.W.	1903
Atkinson, Alfred Ashley, Mines Department, Sydney, N.S.W.	1912
Baker, William H., School of Mines, Thames, N.Z. ..	1911
Banks, Charles A., 155 Sloane Street, London, S.W. ..	1911
§Banks, Edwin G., Box 28, P.O., Waihi, N.Z.	1910
Baragwanath, Wm., Geological Survey Office, Mines Depart., Ballarat, Vic.	1915
Barker, Geo., Rosebery, Tas.	1915
Barr, James (jun.), Cadia Mine, Orange, N.S.W.	1913
Barton, B. V., The Seoul Mining Co., Hol Kol, Whang-Hai Province, Chosen, Korea	1910

Names and Addresses.	Date of Election.
Basedow, Erwin, Pirie-street, Kent Town, S.A.	1906
Bassett, John, Collingwood, Nelson, N.Z.	1911
Battens, Henry, Grenville United Mines Ltd., Camborne, Cornwall, England	1900
Beamish, W. A., Briseis Company, Derby, Tas.	1904
§Beaumont, Edwin K., "Kenilworth," 24 Lewis-street, Lamington-heights, Kalgoorlie, W.A.	1899
§Bell, Dr. James Mackintosh, Almonte, Ontario, Canada ..	1906
¶Bell, Willoughby G., c/o Messrs. Robertson Bros., St. Georges-terrace, Perth, W.A.	1909
Bennett, V. C., 31 Queen-street, Melbourne, Vic... ..	1914
Bennie, Boyd, Bowen-street, Thames, N.Z.	1911
Black, Robert S., Kalgurli G.M. Co., Fimiston, W.A. ..	1909
Blackett, Charles E., Golden Horseshoe Estates Co. Ltd., Boulder, W.A.	1909
¶§Blakemore, G. H., 4 Bridge-street, Sydney, N.S.W. ..	F.
§Bohm, Horace Sanford, Rockhampton, Q.	1898
Boyd, Adam A., Mount Morgan G.M. Co., Ltd., Mount Morgan, Q.	1906
Bradford, Leslie, Broken Hill Pty. Co., Iron and Steel Works, Newcastle, N.S.W.	1910
Bray, Francis P., 103 Elgin-avenue, Maida Vale W., London	1908
Bray, G. E., Charters Towers, Q.	1908
Brett, Henry Tyndall, Albany Chambers, Bulawayo, Rhodesia, South Africa	1912
§Brinsden, Frederick G., Kalgurli G.M. Co., Fimiston, W.A.	1909
¶§Broome, George H., State Coal Mine, Wonthaggi, Vic. ..	1900
Brown, Fred B., Box 1353, P.O., Sydney, N.S.W. ..	1912
§Brown, George F. Campbell, Mount Morgan, Q.	1910
§Browne, D. H., State Coal Mine, Wonthaggi, Vic. ..	F.
Buckley, Henry, Zinc Corporation Ltd., Broken Hill, N.S.W.	1901
Butement, Thomas, School of Mines, Kalgoorlie, W.A. ..	F
Campion, G. W., 18 Carson road, Dulwich, S.E., London	1901
Carlin, M. Henry, Argonaut Mine, St. Helens, Tas. ..	1898
Carroll, John J., Kuaotunu, Auckland, N.Z.	1911
Chambers, Preston, 22 Shortland-street, Auckland, N.Z. ..	1912
§Chapman, Professor R. W., The University, Adelaide, S.A.	1901
Chapple, Albert J. M., Mount Boppy G.M. Co., Canbelego, N.S.W.	1906

Names and Adresses.	Date of Election.
Chomley, W. B., Gt. Fingall Mine, Day Dawn, W.A. ..	1912
Chrisp, Godfrey, Director of Public Works, Port Moresby, Papua	1910
Church, Kenneth C., P.O., Hokitika, N.Z.	1913
Clark, Lindesay C., Derby, Tas.	1905
Clarke, Huntley J., Queenstown, Tas.	1901
Clayton, C. H. J., Mesima, Papua	1913
§Cleland, W. Lauder, Broken Hill Pty. Co , Iron and Steel Works, Newcastle, N.S.W.	1907
Coane, John Montgomery, 70 Queen-street, Melbourne, Vic.	1897
Cock, John, Chiltern, Vic.	1895
§Coldham, J. C., Broken Hill Pty. Co., Broken Hill, N.S.W.	1907
Colley, Walter, Percyville, via Einasleigh, via Cairns, Q...	1914
Conder, Hartwell, Cranbourne-road, Frankston, Vic. ..	1915
Connor, J. D., 144 Barnard-street, North Adelaide, S.A. ..	1910
Coote, Frank J., 21 Royal-crescent, Camberwell, Vic. ..	1905
Copland, Maurice Osric, School of Mines, Ballarat, Vic. ..	1904
Corbould, W. H., Mount Elliott Copper Mines, Ltd., Cloncurry, Q.	1908
§Courtney, Charles Frederick, Sulphide Corporation Ltd., 34 Queen-street, Melbourne, Vic.	1901
§Cowles, Richard K., New Sylvia G.M. Co., Box 55, P.O., Thames, N.Z.	1911
Crozier, Robert H., Hampden-Cloncurry Copper Mines Ltd., Kuridala, North Q.	1909
Crutchett, Edgar A., Great Boulder G.M. Co., Boulder, W. A.	1909
§Cunningham, John C., Broken Hill South Co., Broken Hill, N.S.W.	1902
Currie, David, 30-31 St. Swithens-lane, London, E.C. ..	1911
Daggar, H. James, c/o E. P. Hargraves, 360 Collins-street, Melbourne, Vic.	1901
§Davies, H. Warlow, Y-water Co., Emmaville, N.S.W. ..	1910
Dawson, Edward H., 18 Exchange, Broken Hill, N.S.W. ..	1910
§Delprat, Guillame D., Broken Hill Pty. Co., Equitable Buildings, Melbourne, Vic.	1902
De Lautour, E. A., Ethridge Gold Mines, Forsayth, North Q.	1910
§Denny, G. A., Box 1242, P.O., Johannesburg, South Africa	F.
§Dibdin, T. R., (Beresford & Dibdin), Tilley Chambers, Rockhampton, Q.	1910

Names and Addresses.	Date of Election.
Dickson, Gordon F., London & Rhodesian Mining & Land Co., 5 Moorgate-street, London	1909
Dixon, Clement, Box 305, P.O., Bulawayo, Rhodesia, South Africa	1900
¶Dobbie, H. Campbell, Box 318, P.O., Rangoon, Burma ..	1911
Dods, Richard, Stewart-street, Dulwich, North Adelaide, S.A.	1910
Donaldson, James, Box 272, P.O., Cairns, North Q. ..	1914
§Donaldson, Robert J., Central Mine, Broken Hill, N.S.W.	1905
Donnelly, Alf., c/o Mrs. Harding, Hebbard-street, Sth. Broken Hill, N.S.W.	F.
Doolan, Thomas J., "Carinya," Staniland-grove, Elsternwick, Vic.	1905
Doolette, Dorham L., Nat. Mut. Buildings, St. George's-terrace, Perth, W.A.	1909
Drage, James, Ivanhoe Gold Corporation, Boulder, W.A. ..	1909
§Driffield, E. Carus, Queenstown, Tas.	F.
Dubois, A. J., c/o Chartered Bank of Australia and China, 38 Bishopsgate, London, E.C.	1908
Dunn, A. C., Central Mine, Broken Hill, N.S.W.	1908
Dyason, Edward C., Equitable Building, Melbourne, Vic.	1906
§Dyson, Thomas Ingleby, Britannia House, South Yarra, Vic.	F.
Eastaugh, Frederick A., University Club, Sydney, N.S.W.	1910
Eaton, J. Murdoch, Gaika G.M. Co., Que Que, Rhodesia, South Africa	1905
§Edmands, H. R., Youanmi Gold Mining Co., Youanme, W.A.	1901
Edquist, Victor T., Warriedan Options, via Yalgoo, W.A. ..	1909
Evans, F. H., Boolaroo, N.S.W.	1911
Evans, H. A., Sulphide Works, Boolaroo, N.S.W.	1911
Evans, James H., Gold and Scheelite Pty. Ltd., Golden Point, Macrae's Flat, Otago, N.Z...	F.
Ewart, John, North Broken Hill Mine, Broken Hill, N.S.W.	1910
§Fairweather, Andrew, Broken Hill South Mine, Broken Hill, N.S.W.	1912
Farrier, William Charles Valentine, Mining Inspector, Broken Hill, N.S.W.	1913
Faul, Charles, "Moola," St. Leonard's-avenue, St. Kilda, Vic.	1910
Fisher, D. H., Mount Morgan, Q.	1907
Ford, H. W., 9 Freeman-street, North Fitzroy, Vic. ..	F.

Names and Addresses.	Date of Election.
Foster, Donald F., The Cliffe, Belmont, Sutton-Surrey, England	1913
Frazer, Alex., Great Boulder Pty. Ltd., Boulder, W.A ..	1909
Fraser, Donald Lovat, Blackwater, Q.	1910
Fraser, Colin, c/o Broken Hill Associated Smelters, Collins House, 360 Collins-street, Melbourne, Vic.	1911
§Fraser, S. E., 17 Fairview-road, Mt. Eden, Auckland, N.Z...	1911
Fray, Percival Richard, McMahon-street, St. Arnaud, Vic.	1910
Freeman, Charles Cuthbert, Zinc Corporation Ltd., Broken Hill, N.S.W.	1913
Gall, Wm. C., North Mine, Broken Hill, N.S.W.	1910
Garde, Henry Thomas, Great Boulder Perseverance Gold Mining Co., Fimiston, W.A.	1913
Gardner, W. E., Central Mine, Broken Hill, N.S.W. ..	1902
Garland, Charles L., 11 Moore-street, Sydney, N.S.W. ..	1898
§Gartrell, H. W., The University, Adelaide, S.A.	1910
Gepp, Herbert W., c/o Electrolytic Zinc Co. of Aust., Risdon, Hobart, Tas.	1910
Gibson, Angus A., Mount Morgan, Q.	1910
§Gilchrist, Archibald D., Royal Military College, Duntroon, N.S.W.	1909
§Gilmour, Jas. L., Waihi, N.Z.	1904
Godden, F. W. R., Ivanhoe Gold Corporation Ltd., Boulder, W.A.	1911
§Gordon, Henry A., "Ben Lomond," Ranfurly-road, Epsom, Auckland, N.Z.	1900
Gosman, William Alexander, Queenstown, Tas.	1913
Grace, Wm. Frank, Waihi Grand Junction Co., Waihi, N.Z.	1911
Gray, George J., Gt. Western Hotel, Cobar, N.S.W. ..	1912
Grayson, Lawrence, "Droylsden," Commercial-road, Hyde Park, S.A.	F.
Greenway, T. J., 60 Queen-street, Melbourne, Vic. ..	F.
Greig, E H. c/o Burma Mines Ltd., Nam Tu, Northern Shan States, Burma	1916
Grierson, J. J., Jumbunna Coal Mine, Jumbunna, Vic. ..	1911
Grimmond, Joseph, Ross, N.Z.	1911
§Gudgeon, Cyril W., Mt. Bischoff Extended Tin Mining Co., Waratah, Tas.	1915
§Gunn, Francis, Finnis-street, Gawler, S.A.	1910

Names and Addresses.	Date of Election
Hack, Clem. A., 360 Collins-street, Melbourne, Vic. ..	1905
Hales, Robert G., Magnet, Tas.	1914
Hamilton, Henry J. E., British Mine, North Broken Hill, N.S.W.	1910
§Hamilton, Richard, Great Boulder Pty. G.M. Co., Boulder, W.A.	1906
Hancock, H. Ley, Nungarin, via Merredin, W.A.	1901
§Hancock, H. Lipson, Moonta Mines, S.A.	F.
Hancock, H. R., Nat. Mut. Buildings, King William-street, Adelaide, S.A.	F.
Hansen, L., Birthday Tunnel Co., Berringa, Vic.	1908
Hardman, James T., Torrington, N.S.W.	1913
Hargraves, E. P., Collins House, 360 Collins-street, Melbourne, Vic.	1915
§Hart, G. Stephen, Mount Morgan, Queensland	1910
Hasson, Robt., Hagelthorne-street, Wonthaggi, Vic. ..	1915
Hay, Archibald L., Bullfinch Pty., Bullfinch, W.A. ..	1909
Hayes, William H., Moonta Mines, Moonta, S.A.	1910
§Hebbard, James, Central Mine, Broken Hill, N.S.W. ..	1902
Henderson, Edwin T., Broken Hill Pty. Co., Broken Hill, N.S.W.	1910
§Herman, Hyman, Mines Department, Treasury Buildings, Melbourne, Vic.	1897
Hetherington, J. W., M. L. A. Chambers, Queen-street, Brisbane, Q.	1911
Higgin, Alfred J., The University, Melbourne, Vic. ..	1912
Hitchcock, W. E., Bismuth, Tin and Wolfram Mine, Moina, near Wilmot, Tas.	1904
Hofman, Prof. H. O., Massachusetts Institute of Technology, Boston, Mass., U.S.A.	1914
Hogarth, A., Cloncurry, North Q.	1911
Horsburgh, James, Chillagoe Co. Ltd., Chillagoe, Q. ..	1908
§Horwood, E. J., Broken Hill, N.S.W.	1902
Howden, John McA., The Bungalow, Roche, Cornwall, England	1913
Howe, A. Maxwell, Department of Mines (State Batteries Branch), Perth, W.A.	1901
Hughes, Joseph Albert, School of Mines, Charters Towers, Q.	1911
Hunter, Peter, State Coal Mine, Wonthaggi, Vic. ..	1912

Names and Addresses.	Date of Election.
§Hunter, Stanley B., Mines Department, Treasury Buildings, Melbourne, Vic.	1894
Hylton, C. G., Zinc Corporation Ltd., Broken Hill, N.S.W.	1906
Imanaga, T., Müke, Japan	1917
Ireland, Mark, South Cameron, Tas.	1902
§Jakins, G. Fred., North Lyell, Tas.	1910
James, Eric L., P.O., Lake Boga, Vic.	1910
James, John C., Sulphide-street, Broken Hill, N.S.W. ..	1913
§Jarman, Arthur, Barry-road, Waihi, N.Z.	1910
Jensen, E. Broughton, Bordertown, S.A.	1909
§Jensen, William S., Many Peaks Mine, Many Peaks, Q. ..	1908
§Johns, Frederick C., c/o Junction North Mine, Broken Hill, N.S.W.	1911
Johns, Morgan J., Mount Morgan Co., Mount Morgan, Q.	1909
§Johnston, W. H., Waihi, N.Z.	1904
§Jones, David, Waratah, Tas.	F.
Jones, Henry, Inspector of Mines, Kadina, S.A.	1910
Jowett, W. H., Cr. Cotter and Addis streets, Lamington Heights, Kalgoorlie, W.A	1901
Judge, James, Ravenswood, North Q.	1911
§Kayser, H. W. Ferd., "Offendene," Crimea-street, St. Kilda, Vic.	F.
§Kenyon, A. S., State Rivers and Water Supply Commission, Treasury Gardens, Melbourne, Vic.	1896
Key, John F., British Mine, North Broken Hill, N.S.W. ..	1912
King, A. J., c/o A. W. Freeman, Taiping, Perak, Fed. Malay States	1911
King, E. M., "Leura," Launceston, Tas.	F.
Kingston, Wm., School of Mines, Bairnsdale, Vic.	1914
§Kitson, Albert E., 109 Worple-road, Wimbledon, Surrey, England	1904
Klug, Geo. C., c/o Bewick, Moreing and Co., 360 Collins-street, Melbourne, Vic.	1909
Ladd, David H., 615 Market-street, Scandersky, O., U.S.A.	1911
Lakeland, William J., Bandwin Mines, via Mampwe, Northern Shan States, India	1913
§Larcombe, C. O. G., School of Mines, Kalgoorlie, W.A. ..	1908
Laun, Ernest J., Box 58, P.O., Chillagoe, North Q. ..	1909
§Lavers, Herbert, Block 14 Mine, Broken Hill, N.S.W. ..	1910

Names and Addresses.	Date of Election.
Learmont, Tom, Broadway, Reefton, N.Z.	1911
§Ledeboer, J. H., Broken Hill Pty. Co., Broken Hill, N.S.W.	1913
Leggo, A. Victor, Metallurgical Works, Bendigo, Vic. ..	1908
Leggo, H. M., Mount Korrong-road, Job's Gully, Bendigo, Vic.	1901
Leitch, Walter, Blackball, N.Z.	1911
Lester, Thomas, Mount Morgan Extension Co. Ltd., Mount Morgan, Q.	1911
§Lewis, James B., 31 Queen-street, Melbourne, Vic. ..	1906
Lidgey, Cecil R., G. H. & Co., 36 Queen Victoria Markets, Sydney, N.S.W.	1911
Lilburne, Albert S., The Occidental G.M. Co , Cobar, N.S.W.	1911
Lindsay, John A., Box 196, P.O., Newcastle, N.S.W. ..	1906
Lockyer, Ormonde H. S., Edwards Metallurgical Works, Sebastopol, Ballarat, Vic.	1910
Loring, W. J., London Wall, London	1909
§Low, V. F. Stanley, c/o National Bank of Australasia, Bishopsgate, London, E.C.	1902
Lund, Jens, 64 Clyde-road, Addiscombe, Surrey, England ..	1902
Lyons, C. M., Tavoy, Burma	1916
Macartney, E. H. B., 53 Lewis street, Kalgoorlie, W.A ..	1901
§MacDiarmid, Arch. C., Reotahi, Whangarei Heads, Auckland, N.Z.	1911
Macgeorge, Alex. J., St. Georges-crescent, Glen Iris, Vic. ..	1911
Mackenzie, D. C., Inspector of Mines, Wangaratta, Vic. ..	1910
Macleod, Peter J., The University, Hobart, Tas. ..	1901
§Macleod, W. A., c/o Bewick, Moreing and Co., Kalgoorlie, W.A.	1904
Macnicol, A. N., 31 Queen-street, Melbourne, Vic. ..	1906
Macrossan, Brian, Albion, Brisbane, Q.	1908
M'Conachie, Wm., Waihi Grand Junction Co., Waihi, N.Z. ..	1910
M'Cormick, W. J., Broad-street, Thames, N.Z.	1912
M'Geachie, Duncan, Caledonian Collieries Ltd., Newcastle, N.S.W.	1912
M'Geachie, John, Caledonian Coal Co., Waratah Colliery, Charleston, N.S.W.	1908
M'Keown, Maurice R., Joadge Valley, Mittagong, N.S.W.	1912
§M'Leish, John, State Coal Mine, Wonthaggi, Vic. ..	1912
M'Padden, John F., School of Mines, Reefton, N.Z. ..	1911
Malyon, Frederick W., Waihi G.M. Co., Waihi, N.Z. ..	1911

Names and Addresses.	Date of Election.
MARRIOTT, FREDERICK A., c/o Golden Kopje, G.M. Co., Golden Kopje, Sinvia, Rhodesia, South Africa	1905
MARRYAT, CYRIL B., c/o C. H. Marryat, 33 Grenfell-street, Adelaide, S.A.	1910
MARS, F. J., Broken Hill South Mine Ltd, Broken Hill, N.S.W.	1902
MARSHALL, REGINALD R., Gibbs, Bright & Co., Adelaide, S.A.	1910
MARTIN, EDWARD, 369 Collins-street, Melbourne, Vic. ..	1902
§MATHERS, J. V. W., Mararoa Gold Mining Co., Norseman, W.A.	1914
§MATHESON, ALEX. M., Waratah, Tas.	1913
§MATTERS, CLEM. W., High-street, Unley Park, Adelaide, S.A.	1910
§MAWDSLEY, W. H., P.O., Rockhampton, Q.	1898
MEREDITH, DAVID, Amalgamated Zinc (De Bavay's) Ltd., Broken Hill, N.S.W.	1910
MERRILL, CHAS. W., Room 502, 121 Second-street, San Francisco, Cal., U.S.A.	1908
MERRIN, ARTHUR H., Mines Department, Treasury Buildings, Melbourne, Vic.	1903
MESSENGER, WILLIAM T., Zinc Corporation Ltd., Broken Hill, N.S.W.	1913
MEWES, WILHELM, c/o Noyes Bros, 499 Bourke-street, Melbourne, Vic.	1914
§MICKLE, KENNETH A., c/o Argus Office, 80 Fleet-street, London	1909
MILLETT, BERT, Hodgkinson-street, Charters Towers, Q. ..	1907
MITCHELL, JOHN P., Atlas Buildings, 8 Spring-street, Sydney, N.S.W.	1909
MITCHELL, S. R., 21 Murphy-street, Richmond, Vic. ..	1912
MOEN, OLUF, St. Bathans, Central Otago, N.Z.	1911
MOLINE, ARTHUR H. P., Cock's Pioneer Co., Eldorado, via Wangaratta, Vic...	1909
MOLINEAUX, HERBERT S., The Reefs, Central Otago, N.Z. ..	1911
§MONTGOMERY, A., Department of Mines, Perth, W.A. ..	F.
MOORE, KARL BYRON, Youanmi Gold Mining Co., Youanme, W.A.	1913
MOORE, ROBERT M'I., Macquarie-street, Dubbo, N.S.W. ..	1912
§MORGAN, PERCY G., Geological Survey Office, Wellington, N.Z.	1900
MORSE, PHILLIP S., 157 Walnut-street, Brooklyn, Mass., U.S.A.	1905
MORSE, WILLARD S., Seaford, Del., U.S.A.	1901
§MOSS, FRANK A., Greenbushes, W.A.	F.

Names and Addresses.	Date of Election.
Moulden, J. C., Central Zinc Co., Seaton-Carew, near Middlesborough, England	1906
Moule, John W., Corella Copper Co., via Ballara, Cloncurry, North Q.	1908
Moxon, Claude H. Hercules Gold and Silver Mining Co, Williamsford, Tas.	1915
Mulligan, W. J., Grafton Copper Mines, Cangai, N.S.W. ..	1910
Murdock, Fredk. M., Hampden-Cloncurry Copper Mines Ltd., Cloncurry, North Q.	1915
Murphy, Frank, Great Cobar Ltd., Cobar, N.S.W. ..	1912
Murray, Geo. D., Ivanhoe Gold Corporation Ltd., Boulder, W.A.	1909
§Murray, Russell M., Mount Lyell Mine, Gormanston, Tas.	1911
Murray, Virginius H. R., Lamington Heights, Kalgoorlie, W.A.	1909
Nakamura, Keijiro, Baron Sumitomo's General Head Office, Kitahama, Osaka, Japan	1914
§Newman, J. Malcolm, Pratten Buildings, Jamieson-street, Sydney, N.S.W.	1910
Nicol, W. J., St. Arnaud, Vic.	1910
Nicholson, L'Estrange, Cloncurry, North Q.	1913
Nicolson, R. B., Ivanhoe Gold Corporation Ltd., Boulder, W.A.	1901
Noble, Jas. R., Junction-road, Waihi, N.Z.	1910
O'Brien, Edward, c/o R. N. Kirk, 16 O'Connell-street, Sydney, N.S.W.	1910
O'Brien, Kirk, 360 Collins-street, Melbourne, Vic. ..	1911
Owen, T. Mackellar, 116-118 Clarence-street, Sydney, N.S.W.	1914
§Palmer, Thos. H., Junction North Mine, Broken Hill, N.S.W.	1910
§Patterson, B. G., Mount Morgan, Q.	1907
Paul, Matthew, Inspector of Mines, Waihi, N.Z. ..	1910
§Paull, W. J., "Codrington," Bowenville, Darling Downs, Q.	F.
Payne, Professor Henry, The University, Melbourne, Vic.	1911
§Pearce, W. C. Walworth, Lancelot, via Herberton, Q. ..	1906
Pearson, J. L., Wallaroo Mines, S.A.	1913
Peat, James, Ivanhoe Gold Corporation Ltd., Boulder, W.A.	1914
Peberdy, James R., c/o Australian Institute of Mining Engineers, 57-59 Swanston-street, Melbourne, Vic. ..	1910
Penman, Arthur Percy, City Bank Chambers, Newcastle, N.S.W.	1911

Names and Addresses.	Date of Election
Pettit, Arthur E., 8 Old Jewry, London, E.C.	1905
§Poole, Wm. (Julius & Poole), Culwalla Chambers, Castlereagh-street, Sydney, N.S.W.	1905
Pomroy, H., Wallaroo Mines, S.A.	1913
§Power, F. Danvers, Perpetual Trustees Chambers, 33-39 Hunter-street, Sydney, N.S.W.	F.
Rae, Cecil, Ipoh, Perak, Fed. Malay States	1908
Rankin, Wm. C. F., Howard, Q.	1908
†Raymond, Dr. Rossiter W., 29 West, 39th-street, New York City, U.S.A.	1894
Reed, Frank, Mines Department, Wellington, N.Z. ..	1910
Reid, Major D. E., Gympie, Q.	1910
Rhodes, Charles, Ronaki, Remuera, Auckland, N.Z. ..	1911
§Rhodes, Fred. N., New Zealand Portland Cement Co., Limestone Island, N.Z.	1910
§Richard, G. A., Queensland Club, Brisbane, Q.	1895
Richards, H. P., "Nidus," Wandiligong, Vic.	F.
Ridge, H. M., 2 Gt. Winchester-street, London, E.C. ..	1901
Riechelmann, H., c/o Electrolytic Refining Co., Port Kembla, N.S.W.	1907
§Rigby, Edward J., 482 Collins-street, Melbourne, Vic. ..	F.
Robbie, Wm. G., Waihi, N.Z.	1911
Roberts, Geo. M., Associated Northern G.M. Co., Kalgoorlie, W.A.	1909
§Roberts, Nicholas J., Central Mine, Broken Hill, N.S.W. ..	1913
Rodda, E. J. J., Mouramba Copper Mines Ltd., Nymagee, Q.	1907
Rodda, Stanley N., Working Men's College, Melbourne, Vic.	1910
Rolfe, R. A., 53 West-street, North Sydney, N.S.W. ..	1915
Rose, Walter J., Amalgamated Zinc (De Bavay's) Ltd., Broken Hill, N.S.W.	1909
Rowe, F. Walton, Oroya Links Ltd., Kalgoorlie, W.A. ..	1913
Rusha, Richard A., "Villette," Narbourne-avenue, Clapham Common, London, S.W.	1912
Russell, Murray, Inspector of Mines, c/o Dept. of Mines, Brisbane, Q.	1912
Ryan, Cecil G., Bradshaw's Creek, Tas.	1908
Sander, George E., c/o Burma Mines Ltd., Nam Tu, Northern Shan States, Burma	1910
§Sarvaas, Johan, Working Men's College, Melbourne, Vic. ..	1902

Names and Addresses.	Date of Election.
Saunders, George J., Central Technical College, Brisbane, Q.	1904
Savage, A. E., "Nangeela," Point-road, Woolwich, Sydney, N.S.W.	1911
Schlapp, H. H., 31 Queen-street, Melbourne, Vic.	F.
Scoble, E. J., Hikurangi, Whangarei N.Z.	1917
Scott, Malcolm B., Kalgurli G.M. Co., Fimiston, W.A. ..	1909
Scott, James Balfour, Renison Bell, Tas.	1913
Shaw, J. B., c/o A. B. S. White, Vickery's Chambers, 82 Pitt-street, Sydney, N.S.W.	1910
Shepherd, H. Frank, Thames, N.Z.	1911
§Simson, August, Launceston, Tas.	F.
Skeats, Professor E. W., The University, Melbourne, Vic.	1905
§Slee, Richard T., Broken Hill Pty., Co., Broken Hill, N.S.W.	1902
§Slessor, Robt. Castlereagh House, Castlereagh-street, Sydney, N.S.W.	1905
Smith, A. Mica, School of Mines, Ballarat, Vic.	1906
Smith, C. Lonsdale, Butlers Tin Mines, Torrington, N.S.W.	1905
Smith, C. E. Kennedy, State Battery, Mulline, W.A. ..	1912
§Smith, F. Voss, Block 14 Co., Broken Hill, N.S.W. ..	1909
Smith, J. D. Audley, Box 1557, P.O., Sydney, N.S.W. ..	1910
Somerset, H. St. J., Jun., Great Cobar Ltd., Cobar, N.S.W.	1898
Speight, Robert, Canterbury Museum, Christchurch, N.Z.	1911
Stephenson, Clement T., 39 Wrixon-street, East Kew, Vic.	1912
Stewart, Farquhar, Walsh-street, Reefton, Westland, N.Z.	1910
¶§Stewart, Hector, "Solai," Wagin, W.A.	1902
§Sticht, Robert C., Mount Lyell Mining and Railway Co., Queenstown, Tas.	1901
Stirling, J., Burnie, Tas.	F.
Stokes, C. H., Sth. Kalgurli G.M. Co., Box 100, P.O., Fimiston, W.A.	1910
Stokes, Reginald H., 341 Pitt street, Sydney, N.S.W. ..	1911
Strambini, Dominico, Deighton-street, Ravenswood, North Q.	1913
Süssmilch, C. A., Technical College, Sydney. N.S.W. ..	1904
Sutherland, John W., Golden Horseshoe Estates Ltd., Boulder, W.A.	1909
Sutherland, Wm. G., Smelting Works, Fremantle. W.A. ..	1909
Taylor, E. Hogan, Great Cobar Ltd., Cobar, N.S.W ..	1913
Thomas, Harry A., Block 10 Mine, Broken Hill, N.S.W. ..	1910

Names and Addresses.	Date of Election.
Tom, Isidore, Box 6034, P.O. Johannesburg, Transvaal ..	1909
Townsend, C. T., Cyanide Works, One-Mile, Gympie, Q. ..	1908
Trenerry, Edward Joseph, Moonta Mines, S.A.	1911
Turnbull, T. A., 164 Hardy-street, Nelson, N.Z.	F.
Turner, A. D., Falcon Mines Ltd., via Umvuna, Rhodesia, South Africa	1913
§Turri, G. G., The Rialto, Collins-street, Melbourne, Vic. ..	F.
Ullman, A. T., Gordon-street, Hamilton, N.S.W... ..	1914
Ulrich, Gerhardt A., c/o Inst. of Mining and Metallurgy, Salisbury House, London Wall, London, E.C. ..	1911
Waddell, W. A., Koorboora, via Cairns, Q.	F.
Wainwright, Chas. L., Central Zinc Co., Seaton-Carew, Durham, England	1910
§Wainwright, W. E., Broken Hill South Mine, Broken Hill, N.S.W.	1902
§Wallmann, H. P., Thistle-street, Bendigo, Vic. . ..	1910
Walton, Robert W., Brilliant Block Mill, Charters Towers, Q.	1911
Ward, Osmer B., Block 10 Mine, Broken Hill, N.S.W. ..	1913
Warde, Harvey S, Inspector of Mines, Court House, Rockhampton, Q.	1907
Warne, George, Thames, N.Z.	1911
Waterhouse, Leslie V., c/o Mount Lyell Mining and Railway Co., Queenstown, Tas.	1910
§Waters, Professor D. B., The University, Dunedin, N.Z.	1904
Watson, James T., Chillagoe Ltd., Mt. Mulligam, via Cairns, Q.	1911
Wauchope, A., Sons of Gwalia Ltd., Gwalia, W.A. ..	1909
Webster, William W., Intan, Upper Perak, Fed. Malay States	1912
Weigall, A. R., c/o Seoul Mining Co., Suan Mine, Hol Kol, Whang Hai Province, Korea	1910
Weigall, Henry Stuart, Chosen Gold Mines Ltd., Seoul, Korea	1912
Weinberg, E. A., 19 Queen-street, Melbourne, Vic. ..	F.
Weir, George, 360 Collins-street, Melbourne, Vic.	1902
Wentworth, D'Arcy, 3 Onslow-avenue, Elizabeth Bay, Sydney, N.S.W.	1898
Westcott, L. A., Mount Morgan, Q.	1907
§White, Edmond A., Electrolytic Refining Co., Port Kembla, N.S.W.	1900
White, Francis P., Goonengerry, via Mullunbimby, North Coast, N.S.W.	1913

Names and Addresses.	Date of Election.
§White, Norman F., Rockhampton, Q.	1899
Whitfeld, H. E., The University, Perth, W.A.	1914
Whitley, Alexander, Inspector of Mines, Dunedin, N.Z. ..	1911
Wilkins, Laurence G., 2 Cooper-street, Double Bay, Sydney, N.S.W.	1913
§Williams, Luke, "Claremont," Moonah, Tas.	1894
Williams, Thomas H., Leonora G. Blocks, Leonora, W.A. ..	1910
Wilson, A. L., New Ravenswood Ltd., Ravenswood, Q. ..	1909
Wilson, F. G., Vegetable Creek Co., Emmaville, N.S.W. ..	1910
Wilson, Harry, 31 Queen-street, Melbourne, Vic. .	1914
Wilson, J. Bowie, Wentworth Court, Elizabeth street, Sydney, N.S.W.	1898
Wilson, William T. S., Extraction Works, Pieroa, Auckland, N.Z.	1911
§Wood, James P., School of Mines, Adelaide, S.A.	1910
Worsley, Henry E., Broken Hill Pty. Co., Broken Hill, N.S.W.	1910
§Wright, Geo. W., Queenstown, Tas.	1906
§Wylie, Wm., 121a Main Road, North East Valley, Dunedin, N.Z.	F.
Young, Fletcher, Cloncurry, North Q.	1910
Young, Gerald W., "Rona," Toorak-road, Toorak, Vic. ..	1909

ASSOCIATE MEMBERS.

Alford, L. C., "Oakhampton," Wellington, N.Z.	1910
Anderson, A. F. S., 169 Oakwood Court, Kensington W., London	1914
Atkinson, J., Emmaville, N.S.W.	1907
Avery, John, c/o Electrolytic Zinc Co. of Aust., Risdon, Hobart, Tas.	1912
Avery, Wilfred P., Klong Sa Mine, Tammarat Mining Syndicate, Bandon, Siam	1910
Baldwin, Percy H., Mount Morgan, Q.	1910
Banks, John H. G., Waihi G.M. Co., Waihi, N.Z. ..	1910
Barclay, Fred. E., "Burra Bra," Thinkoswald Avenue, Mosman, Sydney, N.S.W...	1912
Barber, C. S., Pell-street, Broken Hill, N.S.W.	1915

Names and Addresses.	Date of Election.
Barker, Nigel Chase, Atlas Buildings, Spring-street, Sydney, N.S.W.	1911
Barkley, Ernest, Mount Lyell Batch, Gormanston, Tas. ..	1906
Beckwith, Ralf N., Mount Gunson Mine, Port Augusta, S.A.	1910
Black, Arnold B., 8 Zebina-street, Broken Hill, N.S.W. ..	1912
Blyth, William B., Golden Kopje Pty. Mines Ltd., Lomagundi, Sth. Rhodesia, South Africa	1911
Boydell, W. G. B., c o Seoul Mining Co., Hol Kol Mine, Whang Hai Province, Chosen, Korea	1911
Bowater, W. H., Government Assay Office, Cloncurry, Q. ..	1910
Bridge, John M., Zinc Corporation Ltd., Broken Hill, N.S.W.	1907
Brown, G. Twentyman, "Glenfern," Mathoura-road, Toorak, Vic.	1910
Brown, H. Wheeler, Broken Hill Pty. Co., Broken Hill, N.S.W.	1913
Bullen, G. L., Block 14 Torrington, Bismuth, via Deepwater, N.S.W.	1913
Burbidge, Percy, Mount Shamrock Mine, Mount Shamrock, Q.	1910
Caithness, W. R., c/o Fraser and Chalmers Ltd., Equitable Building, Melbourne, Vic.	1909
Campbell, A. G., "Kia-Ora," Bay-road, Sandringham, Vic.	1911
Campbell, J. K., Stannary Hills, via Cairns, Q.	1915
Carless, Noel, Walney House, Waihi, N.Z.	1913
Christian, Arthur J., The Ranch, Oxide-street, Broken Hill, N.S.W.	1910
Clapp, L. P., 76 Chloride-street, Broken Hill, N.S.W. ..	1910
Clark, Archie S., Grafton Copper Co., Cangai, N.S.W. ..	1910
Clayton, Edward, Great Fingall Mine, Day Dawn, W.A.	1912
Cole, William H., Waihi Grand Junction Ltd., Waihi, N.Z.	1912
Collison, Arthur G., King William-street, Adelaide, S.A...	1902
Cooke, Herbert R., 4 Kidd's Building, High-street, Auckland, N.Z.	1911
Corstophan, V. A., c/o Electrolytic Zinc Co. of Aust., Risdon, Hobart, Tas.	1915
Coulter, Leslie J., Mount Lyell Batch, Gormanston, Tas.	1914
Court, A. Lacy, Central Mine, Broken Hill, N.S.W. ..	1913
Courtney, Guy, c/o Sulphide Corporation Ltd., Newcastle, N.S.W.	1912
Crace, Melville C., Broken Hill South Mine, Broken Hill, N.S.W.	1911

Names and Addresses.	Date of Election.
Craig, J. H., Albion Chambers, Bendigo, Vic.	1911
Cribb, H. B., Lower Quarters, Mount Morgan, Q.	1910
Cumming, Alex., Irvinebank Co., Irvinebank, North Q. ..	1911
Danks, Aaron T., 391 Bourke-street, Melbourne, Vic. ..	1905
Dart, Riverine N., Box 7, P.O., Cobar, N.S.W.	1912
Delprat, Theodore D., c/o R. N. Kirk, O'Connell street, Sydney, N.S.W.	1910
Dempster, Geo. C., Stock Exchange Buildings, Adelaide, S.A.	1910
Ditchburn, Gordon L. A., Ivanhoe Gold Corporation, Boulder, W.A.	1910
Dod, H. Charlton, "Knowsley," Broadway, East Camberwell, Vic.	1914
Dow, Edmund B., Central Mine, Broken Hill, N.S.W. ..	1910
Dow, John, Golden Horseshoe Estates Ltd., Boulder, W.A.	1910
§Drain, Percy J., "Kingsley," Kitchener-road, Artarmon, Sydney, N.S.W.	1910
Dunstan, Basil G., c/o Jno. Dunstan, Churchill Chambers, 61 Market street, Sydney, N.S.W.	1911
§Edwards, Ed., 2 Soudan-street, Malvern, Vic.	1907
Elford, Chas., Rishton, via Charters Towers, Q. ..	1910
Finlayson, R. J. Stanley, Walhalla, Vic.	1911
Fisher, W. Hamilton, 46 Ward-street, Kalgoorlie, W.A. ..	1913
Flockhart, Colin P., Champion Reef G.M., Kolar, Mysore Province, Southern India	1912
Fox, James Michael, North Mine, Broken Hill, N.S.W. ..	1910
Foxhall, John S., Longueville, Sydney, N.S.W.	1912
§Fry, Sidney, Westport, N.Z.	1907
Garrett, James E., Commercial Hotel, Broken Hill, N.S.W.	1912
Getly, Andrew, 7 Victoria-street, Kalgoorlie, W.A. ..	1915
Gluyas, B. C., Zinc Corporation Ltd., Broken Hill, N.S.W.	1913
Greening, Walter, Waiorongomai, N.Z.	1911
Greenlees, Alan D., Amalgamated Zinc (De Bavay's) Ltd., Broken Hill, N.S.W.	1910
Grieve, William H., c/o William Adams and Co., 175 Clarence-street, Sydney, N.S.W.	1911
Grosse, William J., 49 Patton-street, South Broken Hill, N.S.W.	1913
Guppy, Clarence H. R., Pinnacles Mine, Broken Hill, N.S.W.	1911
Haigh, Victor A., Block 10 Mine, Broken Hill, N.S.W. ..	1910

Names and Addresses.	Date of Election.
HALLETT, CHARLES M., 110 Gawler-place, Adelaide, S.A. ..	1911
HAMMEL, HENRY E., "Yamba," Esplanade, St. Kilda, Vic.	1913
HARRIS, FRANK G., Amalgamated Zinc (De Bavay's) Ltd., Broken Hill, N.S.W.	1910
HARVEY, PHILLIP, School of Mines, Charters Towers, Q. ..	1910
HERBERTSON, ROBERT C., Stannifer Freehold Deep Lead Tin Mines, Toppers Mountain, Tingha, N.S.W. ..	1910
HEYCOCK, C. R., Moretown, Wairio, Southland, N.Z. ..	1914
HOLDER, EVAN M., Central Mine, Broken Hill, N.S.W. ..	1910
HOOKE, ARTHUR W., Forum River (Nigeria) Tin Co. Ltd., Naraguta, Northern Nigeria, West Africa	1911
HOOKINGS, HERBERT J., Assay Office, Broken Hill Pty. Ltd., Broken Hill, N.S.W.	1911
HOPE, G. B., Cambushkenneth, Byrock, N.S.W.	1911
HORSBURGH W. W., Hampden-Cloncurry Copper Mines Ltd., Kuridala, North Q.	1911
HUNTER, GEORGE M'I., Central Mine, Broken Hill, N.S.W.	1910
IRVINE, C. L., Mill Stream Station, Roebourne, W.A. ..	1913
JONES, VINCENT N., Shire Office, Rawelli, Gayndah, Q. ..	1910
LAWN, CHARLES H. Opunake, Taranaki, N.Z.	1911
LEEVERS, WILLIAM T., Great Boulder Perseverance G.M. Co., Fimiston, W.A.	1910
LE SOUEF, SEBERT G., Butler's Tin Mine, Torrington, N.S.W.	1910
LEWIS, K. B., "Remo," 41 Kooyong road, Armadale, Vic. ..	1915
MACGRUER, D. C., New Ravenswood, Ravenswood, Q. ..	1915
MACKAY, ALEXANDER D., c/o Mount Bischoff Co., Waratah, Tas.	1913
M'ARTHUR, DUNCAN T. B., Waihi Grand Junction Co., Waihi, N.Z.	1912
M'CALLUM, N. S. KELLIE, c/o Dr. R. W. Young, "Beckenham," 148 Botany-road, Botany, N.S.W.	1911
MCKAY, JAMES, Box 55, P.O., Greymouth, N.Z.	1911
MONTGOMERY, JOHN N., School of Mines, Bairnsdale, Vic. ..	1914
§MOORE, MALCOLM S., c/o W. Beardmore & Co., Parkhead Forge, Glasgow, Scotland	1912
§MORGAN, R. J., Spassky, Zavod, Akmolinsk, Siberia ..	1911
MORISON, DAVID N., Newcastle, N.S.W.	1911
MORRIS, A. C., Zinc Corporation Ltd., Broken Hill, N.S.W.	1913
NEVETT, RALPH D., Thomas-lane, off Chloride-street, Broken Hill, N.S.W.	1912

Names and Addresses.	Date of Election.
Newbigin, William J., c/o William Adams and Co., 612 Collins-street, Melbourne, Vic.	1913
Osborne, George W., Queen of the Hills Co., Meekatharra, W.A.	1913
§Ower, Leslie H., State Coal Mine, Wonthaggi, Vic. ..	1910
Patterson, R. H., Broken Hill Club, Broken Hill, N.S.W.	1912
Rabling, H., St. Joseph's Lead Mines, Bonne Terre, Mo., U.S.A.	1914
Rain, Allan D. M., Braden Copper Mines, Rancagua, Chili, South America	1911
Reid, G. D., Box 17, P.O., Avoca, Vic...	1916
Robson, H. Carmichael, The Spassky Copper Mine Ltd., Akmolinsk, Siberia	1913
Rogers, George, Gwalia, W.A.	1913
Ross, C. N., The University, Brisbane, Q.	1907
Rutherford, Alex. R., Globe Mine, Reefton, N.Z. ..	1913
Rutherford, T. Wyville L., Consolidated Goldfields, Reefton, N.Z.	1913
Rutter, Hubert, "Yarra Braes," Eltham, Vic.	1908
Ryan, Denis L., Fremantle Trading Co., Fremantle, W.A...	1917
Salter, John W., Hampden-Cloncurry Copper Mines Ltd., Kuridala, North Q.	1912
Schwilk, B. J., Blende-street, Railway Town, Broken Hill, N.S.W.	1911
Seale, Harry V., Junction North Mine, Broken Hill, N.S.W.	1910
§Sewell, Robert M., Macgregor Mine, via Cloncurry, North Q.	1913
Shaw, John F., Block 14 Mine, Broken Hill, N.S.W. ..	1912
§Shellshear, Wilton, 178 Chloride-street, Broken Hill, N.S.W.	1910
Simpson, James, Mining Registrar, Kalgoorlie, W.A. ..	1910
Skerritt, Alfred W., Kapsan Mines, Korea	1907
Sligo, A. D., Zeehan, Tas.	1911
Smith, R. D., Hampden-Cloncurry Copper Mines Ltd., Trekelano, via Duchess, Cloncurry, Q.	1908
Smith, Walter G. A., Gt. Cobar Ltd., Chessney Mine, Wrightville, Cobar, N.S.W.	1912
Stanger-Leathes, A. C., 14 MacArthur-street, Ballarat, Vic.	1912
Stephen, Fenton W., Broken Hill Pty. Co., Broken Hill, N.S.W.	1910
Stephenson, Godfrey., Stannary Hills, Q.	1917
Stephenson, Herbert, "Beaumaris," Fletcher-street, Bondi, Sydney, N.S.W.	1910

Names and Addresses.	Date of Election.
STICHNOTH, LUDWIG F., Box 47, P.O., Mt. Morgan, Q. ..	1910
STUTTERD, LOUIS N., P.O., Port Darwin, Northern Territory	1910
SWEET, OSWALD G., South Extended Mine, Broken Hill, N.S.W.	1910
TANDY, A. E., c/o Mrs. S. A. Writer, "Glen Rowan," Warreemba-road, Abbotsford, N.S.W.	1915
THOMAS, FRANK N., South Mine, Broken Hill, N.S.W. ..	1911
THOMPSON, F. D., c/o Eastern Smelting Co. Ltd., Penang, Straits Settlement	1908
TITMUS, CHARLES J., 109 Pitt-street, Sydney, N.S.W. ..	1912
TOPP, A. A., 12 Cromwell road, Hawksburn, Vic.	1909
TORPY, H. E., Junction Mine, Broken Hill, N.S.W. ..	1913
TOWNSEND, HAROLD, "The Wurlie," Iodide-street, Broken Hill, N.S.W.	1910
TRELOAR, FRED. L., Oxide-street, off Morgan-lane, Broken Hill, N.S.W.	1913
TURNER, TOM H., "Aldinga," 73 Ormond Esplanade, Elwood, Vic.	1917
TWINE, GEORGE J., c/o N. S. West, Gretna Township, H.M. Factory, Gretna, Carlisle, England	1914
VAUGHAN, RUPERT M., "The Batch," Briseis Tin Mine, Derby, Tas.	1911
WAINE, VICTOR J., Colonial Sugar Refining Co., Sigatoka, via Lantoka, Fiji	1908
§WARREN, P. HAMPTON, Broken Hill South Mine, Broken Hill, N.S.W.	1910
§WATKINS, AUGUSTUS E., St. Aubyn-street, New Plymouth, Taranaki, N.Z.	1911
WATSON, HERBERT, c/o Amalgamated Zinc (De Bavay's) Ltd., Broken Hill, N.S.W.	1911
WHITE, FREDK. G. (White & Hosier), Broken Hill, N.S.W.	1911
WHITEHEAD, EDWIN A., Union Bank, King William-street, Adelaide, S.A.	1902
WHITEMAN, WOODLEIGH D., The Cam and Motor Mines, Eiffel Flats, Southern Rhodesia, South Africa	1913
WHITINGTON, BERTRAM., Mt. Lyell School of Mines, Queenstown, Tas.	1915
WILLIAMS, ARTHUR, Oxide Creek Ltd., Mt. Gordon Mine, via Cloncurry, Q.	1915
WILLIAMS, OWEN B., Block 14 Mine, Broken Hill, N.S.W. ..	1910

Names and Addresses.	Date of Election.
§Williams, R. T. D., Amalgamated Zinc (De Bavay's) Ltd., Broken Hill, N.S.W.	1910
Williams, W. Ewart, Block 10 Mine, Broken Hill, N.S.W.	1912
Wilson, Wilfred A., Box 73, P.O., Whangarei, N.Z.	1911
Winters, R. J., Department of Mines, Northern Territory	1914
Woodward, Oliver H., Officers Quarters, Mt. Morgan G.M. Co., Mt. Morgan, Q.	1909
Zeugofsge, F. C., 181 Patton-street, South Broken Hill, N.S.W.	1910

STUDENTS.

Adcock, Garnet I., Viticultural College, Rutherglen, Vic.	1911
Alexander, Hubert, Black Range West G.M. Co., Sandstone, W.A.	1912
Anderson, Archibald G., 25 Armadale-street, Armadale, Vic.	1913
Anderson, E. S., c/o R. E. Chapman, Bank of New South Wales, Ballarat, Vic.	1912
Anderson, Wm. T., "Clifton," Ben Boyd-road, Neutral Bay, N.S.W.	1910
Barson, Thomas L., Railway Town, Broken Hill, N.S.W.	1913
Berriman, Ralph V., "Bolton," Daphne-street, Prospect, S.A.	1913
Best, George H. T., Sons of Gwalia Ltd., Gwalia, W.A.	1911
Blair, F. A., Central Mine House, South Road, Broken Hill, N.S.W.	1912
Bloom, Leo, Merivale-street, South Brisbane, Q.	1913
Blunden, Leslie E., 228 Elizabeth-street, Brisbane, Q.	1910
Burns, Felix G., Terminus Hotel, Williamsford, Tas.	1914
Carroll, H. H., 3 Pleasant-street, Ballarat, Vic.	1915
Casey, Richard G., 125 William-street, Melbourne, Vic.	1909
Cherry, Henry W. S., "The Towers," Sulphide-street, Broken Hill, N.S.W.	1913
Combe, A. D., Palace Hotel, Argent-street, Broken Hill, N.S.W.	1912
Corrie, Colin C., Cutten-street, Queenstown, Tas.	1911
Craigie, A. K., Palace Hotel, Broken Hill, N.S.W.	1911
Crawford, H., School of Mines, Thames, N.Z.	1912
Dean, Harry M., School of Mines, Charters Towers, Q.	1911
Fabrikant, I. B., 20 Erskine-street, North Melbourne, Vic.	1915

Names and Addresses.	Date of Election.
Ford, Norman, Tarquah Mine, Tarquah, via Seccondee, Gold Coast, West Africa	1910
Fraser, Ernest H., Box 157, P.O., Broken Hill, N.S.W. ..	1911
Gabriel, E. Escott, 108 Westbury-street, St. Kilda, Vic. ..	1910
Goode, Kenneth B., Stephens-place, Adelaide, S.A. ..	1913
Grut, L. de Jersey, School of Mines, Ballarat. Vic. ..	1913
Hart, William, Ryan's Hotel, Gormanstown, Tas. ..	1913
Hill, James, Box 15, P.O., Mount Morgan, Q.	1907
Hooper, Francis H., Block 14 Mine, Broken Hill, N.S.W...	1911
Horn, A. E., Globe Mine, Reefton, N.Z.	1912
Horsley, Ralf D., Stannary Hills, North Q.	1910
Hughes, Eric W., American River, via Hog Bay, Kangaroo Island, S.A.	1913
Jowett, A. C., Trinity College, Parkville, Melbourne, Vic. ..	1909
Kelly, A. H., 1 Lemington-street, Glenelg, S.A.	1913
Kelly, Monckton B. H., Trinity College, Parkville, Melbourne, Vic.	1913
Kneebone, Christopher S., Woodville-road, Woodville, S.A.	1914
Langford, W. G., Vailala Oil Fields, Papua	1915
MacDonnell, Wm. H. A., c/o Mrs. MacDonnell, Harrietville, c/r Gibbs and Herston Roads, Brisbane, Q. ..	1911
Marks, Douglas G., "Sundridge," Lindsay-street, Neutral Bay, Sydney, N.S.W.	1912
Moore, R. Ingram, "Roseneath," Liverpool-road, Summer Hill, N.S.W.	1910
Mulligan, Edric N., Box 89, P.O., Cobar, N.S.W. ..	1910
Nicholas, Frank H., c/o F. G. T. Nicholas, Metal Exchange, Queen-street, Melbourne, Vic.	1913
Paull, N. C., Hampton-Cloncurry Copper Mines Ltd., Cloncurry, North Q.	1910
Pearce, T. R , Geological Survey, Gympie, Q.	1910
Pearson, H. F., Zinc Corporation Ltd., Broken Hill, N.S.W.	1912
Pethebridge, H. V., 48 Fellows-street, Kew, Vic., ..	1915
Pearson, Harold F., Zinc Corporation Ltd., Broken Hill, N.S.W.	1912
Plant, G. H. D., "Thornburgh," Charters Towers, Q.	1910
Roberts, Reginald A. J , "Clydeville," Beryl-street, Broken Hill, N.S.W.	1912

Names and Addresses.	Date of Election.
Russell, James L., c/o P. O'C. Russell, Elizabeth-street, Brisbane, Q.	1913
Smith, Eugene, "The Towers," Sulphide-street, Broken Hill, N.S.W.	1913
Smith, Roy S., "Spotswood," Hodgson-street, Randwick, Sydney, N.S.W.	1914
Smith, W. F., School of Mines, Charters Towers, Q. ..	1913
Southon, Ronald D., Broken Hill South Mine, Broken Hill, N.S.W.	1912
Strutt, S. S., Jun., "Glenmore," 30 Grey-street, St. Kilda, Vic.	1906
Symonds, G. B. L., The University, Adelaide, S.A. ..	1916
Taylor, Augustus, "Walsall," Ferrier-street, Rockdale. N.S.W.	1908
Taylor, E. Foulkes, c/o Mrs. C. F. Bethell, Cheam Park, Cheam, Surrey, England	1913
Thompson, David, Cardross, Q...	1910
Tucker, Virgil, Zinc Corporation Ltd., Broken Hill, N.S.W.	1911
Turner, William A., Wentworth-avenue, Canterbury, Melbourne, Vic.	1914
Uren, Wm. T., Kuridala, via Cloncurry, North Q. ..	1909
Veitch, Neil A., Hampton-Cloncurry Copper Mines Ltd., Kuridala, North Q.	1911
Williams, W. H. Jun., Assistant Inspector of Mines, Rockhampton, Q.	1910
Wishart, J. W., Naval Department, Williamstown, Vic. ..	1914
Yates, Donald, Lefevre Terrace, North Adelaide, S.A. ..	1914

PROCEEDINGS

OF THE

AUSTRALASIAN

Institute of Mining Engineers.

NEW SERIES.

No. 26.

21492
18:10:27

EDITED BY THE SECRETARY.

This Institute is not responsible, as a body, for the facts and opinions advanced in any of its publications.

30th JUNE, 1917.

PUBLISHED QUARTERLY BY THE AUSTRALASIAN INSTITUTE OF MINING ENGINEERS, MELBOURNE.

Australasian Institute of Mining Engineers.

LIST OF OFFICERS, 1917.

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Richard Hamilton	Western Australia
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George C. Klug	Western Australia
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South Australia	Professor R. W. Chapman, Adelaide
New South Wales	F. Danvers Power, Sydney.
Western Australia	F. W. R. Godden, Kalgoorlie.
New Zealand	D. B. Waters, Dunedin.
Tasmania	Russell M. Murray, Mount Lyell.
North Queensland	Murray Russell, Cloncurry.

Branch Secretaries:

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Broken Hill	J. M. Bridge, c/o Zinc Corporation Ltd., Broken Hill, N.S.W.
Mount Morgan	B. G. Patterson, Mount Morgan, Q.

The Executive Committee consists of all Members of the Council residing, or for the time being, in Melbourne.

Head Office:

57-59 Swanston Street, Melbourne, Victoria.

Institute Matters.

CONTENTS.

	Page
MINUTES OF MEETINGS—	
Of the Executive Committee	xliii
NOTICES	xlvi
PUBLICATIONS—Added to Library	xlviii
RECENT ARTICLES—On Mining Matters	l

MINUTES OF MEETINGS.

OF THE EXECUTIVE COMMITTEE.

(Summary).

MARCH 26TH, 1917—1 P.M.

The Secretary's report was presented and accounts to the amount of £47, including printing £18, were passed for payment.

Estimates of Receipts and Expenditure for the current year were submitted by the Finance Committee and adopted.

Nominations of Mr. Gilbert Rigg as a Member and Mr. Harry Jackson Myles as an Associate Member were submitted and approved.

The following were elected to the Institute :—Members—Messrs. T. Imanaga and E. J. Scoble. Associate Members—Messrs. Denis L. Ryan, Tom H. Turner and Godfrey Stevenson.

Professor R. W. Chapman of Adelaide University, was appointed Local Correspondent for South Australia.

Amendments suggested to the clause re signatures to prospectuses, recommended for insertion in the proposed Federal Companies Act were submitted and revised.

Resolved that the sum of £5 be donated to the New South Wales Branch of the Australian Mining Corps Comforts Fund, and a similar amount to the Victorian Branch.

Resolved that space be reserved in the Proceedings for the insertion of Members' professional cards at the rate of 5s. for one insertion or 10s. per year (four insertions).

The Secretary was authorized to take steps to establish an employment exchange on behalf of Members and to notify Members and Mining Companies accordingly.

It was resolved that space be reserved in the Proceedings for small paragraphs concerning the movements of Members, that Members be so notified by medium of the Proceedings and requested to notify the Secretary of any items of interest concerning themselves or their fellow workers.

APRIL 30TH, 1917—1 P.M.

The Secretary's report was presented and accounts to the amount of £24 were passed for payment.

The nomination of Mr. Frederick J. Davies as an Associate Member was approved.

Resignations of Messrs. Frank Reed, W. Ewart Williams and Theo. D. Delprat were submitted and accepted.

Further consideration was given to subject—signatures to prospectuses.

Resolved that the Federal Advisory Council of Science and Industry be invited to consider the question of the establishment of the following industries :—

(1) De-tinning of tin scrap.

(2) Production of wood pulp for use in the manufacture of explosives.

MAY 28TH, 1917—1 P.M.

The Secretary's report was presented and accounts to the amount of £77, including printing £40, were passed for payment.

It was reported that the scheme for the establishment of Bursaries for Students in Mining and Metallurgy had been framed and that particulars would shortly be available.

A number of letters were submitted from Mining Companies offering to assist the Institute in the establishment of an employment bureau on behalf of its Members.

Final consideration was given to the subject—signatures to prospectuses, and the clause as revised was adopted.

JUNE 25TH, 1917—1 P.M.

The Secretary's report was presented and accounts to the amount of £26 were passed for payment.

At the invitation of the Federal Treasurer it was decided that War Savings Certificates be purchased with the amount received by the Institute as interest on Commonwealth Inscribed Stock.

The application of Mr. Walter G. Langford for transfer from the grade of Student to that of Associate Member was approved.

A letter was submitted from the British Trade Commissioner reporting that the British Engineers' Association was prepared to make an offer for the training of apprentices from Australia in Great Britain, and it was decided that the Institute co-operate in any concrete scheme for bringing the matter under the notice of the various technical Associations.

Other routine business was transacted.

NOTICES.

The rooms of the Institute are open from 9.30 A.M. to 10 P.M. daily, except Sundays and Public Holidays.

MEMBERSHIP.

Application for admission to the Institute as Associate Members have been received from Frederick J. Davies, St. Helens, Tas., and Walter G. Langford, Vailala Oilfields, Papua, whose names are now submitted to Members for confidential report.

LOCAL CORRESPONDENTS.

Professor R. W. Chapman of the Adelaide University is now Local Correspondent of the Institute for South Australia.

Mr. F. W. R. Godden of the Ivanhoe Gold Corporation, Boulder, is Local Correspondent for Western Australia.

PUBLICATIONS.

Members are reminded that papers are desired for publication in the Proceedings, also discussions on papers already published. Suggestions from Members regarding subjects for papers and the names of any likely authors are invited.

ON ACTIVE SERVICE.

The following Members have reported their enlistment since the last issue of Proceedings:—

Drain, Percy J.	Peberdy, J. R.
Eastaugh, F. A.	Plant, G. H. D.
Kelly, A. H.	Warde, Harvey S.

Honor Won.

Captain R. Ingram Moore was decorated with the D.S.O. by His Majesty the King on 17th April, 1917, for conspicuous bravery during the Gallipoli campaign.

Killed in Action.

Major Leslie Coulter, D.S.O., who left Australia on 1st March, 1916, with the First Mining Corps, was killed in action in France on 30th June, 1917. He was 28 years of age. Major Coulter

was, prior to enlistment, assistant surveyor to the Mount Lyell Mining and Railway Company and distinguished himself by his bravery in connection with the fires at the North Lyell Mine some years ago. He was wounded in August, 1916, and was awarded the D.S.O. as reported in a previous number of Proceedings. His parents reside in Ballarat.

MOVEMENTS OF MEMBERS.

G. A. Denny, of Johannesburg, South Africa, is in England engaged in war work. His postal address is c/o M. Bennett, Chelmsford Road, Berea, Durban, South Africa.

Edward C. Dyason is now Managing Director of the Bendigo Amalgamated Goldfields No Liability, and is, consequently, most of his time in Bendigo.

W. B. Blyth and F. A. Marriott have opened an office in Bulawayo, Rhodesia, and will do consulting work as well as operate mines themselves.

R. H. Crozier is now in charge of the flotation mill at the Hampden Cloncurry Mine, North Queensland.

R. S. Black (President) has just returned to Kalgoorlie after a short visit to Melbourne.

H. W. Gepp is now General Manager of the Electrolytic Zinc Co. Pty. Ltd., whose works are established at Risdon Road, near Hobart, Tasmania.

H. St. J. Somerset has been appointed Plant Superintendent of the Broken Hill Associated Smelters, at Port Pirie, South Australia.

Hector Stewart has been elected a member of the Legislative Council of Western Australia.

Robert C. Sticht, General Manager of the Mount Lyell Mining and Railway Company is at present on a visit to America.

Walter G. Langford is now in Papua as a cadet at the Vailala Oilfields, Papua.

J. N. Montgomery has been appointed Geological Surveyor to the Vailala Oilfields, Papua. He was formerly on the Staff of the Bairnsdale School of Mines.

LIST OF PUBLICATIONS ADDED TO THE LIBRARY

From 31st March 1917, to 30th June, 1917.

Australian Mining Standard	weekly	Melbourne
Australian Mining and Engineering Review	monthly	Melbourne
Engineering and Mining Journal	weekly	New York
Iron and Coal Trades Review	weekly	London
Mining Journal	weekly	London
Mining and Scientific Press	weekly	San Francisco
The Colliery Engineer	monthly	Scranton, Pa.
Mining and Engineering World	weekly	Chicago
Mining Magazine	monthly	London
Indian Engineering	weekly	Calcutta
Chemical News	weekly	London
South African Engineering	monthly	London
Journal of Industrial and Engineering Chemistry	monthly	Easton, Pa.
Society of Chemical Industry: Journal	bi-monthly	London
Chemical, Metallurgical and Mining Society of South Africa: Journal	monthly	Johannesburg
Franklin Institute: Journal	bi-monthly	Philadelphia
Institution of Mechanical Engineers: Journal	monthly	London
Metallurgical and Chemical Engineering	monthly	New York
Chamber of Mines of Victoria: Monthly Mining Report		Melbourne
Chamber of Mines of Western Australia: Journal	monthly	Kalgoorlie
The West Australian Mining, Building and Engineering Journal	weekly	Perth
Queensland Department of Mines: Government Mining Journal	monthly	Brisbane
Transvaal Chamber of Mines: Monthly Analysis of Production		Johannesburg
Rhodesia Chamber of Mines: Report of Executive	monthly	Bulawayo
Department of Mines, New South Wales: Mineral Resources, No. 23 and 24		Sydney

Northern Engineering Institute :
Presidential Address, by J. Mackenzie - Newcastle
Department of Mines, Queensland :
Geological Survey, Publication, No. 257 - Brisbane
University of Adelaide : Calendar, 1917 - - Adelaide
Department of Mines, South Australia :
Metallurgical Report, No. 2 - - - Adelaide
Department of Chemistry, South Australia :
Bulletin, No. 8 - - - - Adelaide
Department of Mines, New Zealand :
Geological Survey, Bulletin, No. 18 - - Wellington
Institution of Mining and Metallurgy :
Bulletins, Nos. 150 and 151 - - - London
Institute of Chemistry of Great Britain and Ireland :
Proceedings, 1917, Parts I. and II. - - London
Geological Society :
Quarterly Journal, No. 285 - - - London
Institution of Mining Engineers :
Transactions, Vol. LII., Parts 3 and 4, Vol. LIII., Part I. London
Société Des Ingenieurs Civils De France :
Bulletin, December, 1916
Proceedings, 1917, No. 3 - - - Paris
Annales des Mines :
Vol. V., Pages, 231-329 - - - Paris
Real Academia De Ciencas :
Revista, Vol. XIV., No. 12., Vol. XV., Nos. 1-5 Madrid
American Society of Civil Engineers :
Transactions, Vol. LXXX. - - - New York
Field Museum of Natural History :
Report Series, Vol. V., No. 1 - - Chicago
American Institute of Mining Engineers :
Bulletins, No. 123-125 - - - New York
California State Mining Bureau :
Bulletin, No. 73 - - - - Sacramento
United States Geological Survey :
Bulletins Nos. 618 and 619 - - - Washington
Instituto Geologico De Mexico :
Transactions, Vol. V., Nos. 4 and 5 - - Mexico

RECENT ARTICLES ON MINING MATTERS.

(31st March, 1917, to 30th June, 1917).

NOTE.—*This list is prepared for the purpose of placing before members the titles of the more important papers appearing in the usual publications concerned with mining engineering, metallurgy, &c., due regard being had to Australasian requirements.*

LIST OF PUBLICATIONS.

References are given by the number prefixed to each publication in the attached list. Wk., weekly; mth., monthly.

(1) *The Australian Mining Standard*, Melbourne, Victoria, wk., 6d.

(2) *The Queensland Government Mining Journal*, Brisbane, mth., 6d.

(3) *Metallurgical and Chemical Engineering*, New York, mth., 25c.

(4) *The Mining Journal*, London, E.C., wk. 6d.

(5) *Mining and Engineering World*, Chicago, wk., 10c.

(6) *The Engineering and Mining Journal*, New York, wk., 15c.

(7) *The Colliery Engineer*, Scranton, Pa., U.S.A., mth., 20c.

(8) *Mining and Scientific Press*, San Francisco, Cal., wk., 10c.

(9) *Annales des Mines*, Paris, France, mth.

(10) *Publications*, Department of Mines, Melbourne, Victoria.

(11) *Publications*, Department of Mines, Sydney, New South Wales.

(12) *Publications*, Department of Mines, Adelaide, South Australia.

(13) *Publications*, Department of Mines, Brisbane, Queensland.

(14) *Publications*, Department of Mines, Perth, Western Australia.

(15) *Publications*, Department of Mines, Hobart, Tasmania.

(16) *Publications*, Geological Survey, Canada, Ottawa, Ontario.

(17) *Publications*, Bureau of Mines, Toronto, Ontario.

(18) *Publications*, Geological Survey of India, Calcutta.

(19) *Publications*, Geological Survey, U.S.A., Washington.

(20) *Publications*, Geological Survey, Alabama, Montgomery, Ala.

(21) *Publications*, California State Mining Bureau, Sacramento, Cal.

(22) *Reports* Aust. Assoc. Adv. Science, Sydney, New South Wales.

(23) *Transactions and Proceedings*, New Zealand Inst., Wellington, New Zealand.

(24) *Quarterly Journal*, Geological Society, London.

(25) *Transactions*, Inst. Mining and Metallurgy, London, E.C.

(26) *Transactions*, Inst. Min. Eng., London.

(27) *Journal*, Canadian Mining Inst., Ottawa, Ontario.

(28) *Journal*, Chem., Min., and Met. Soc. of S.A., Johannesburg, Transvaal.

(29) *Transactions*, Am. Inst. of Min. Eng., New York City.

(30) *Proceedings*, Colorado Scientific Soc., Denver, Col.

(31) *Journal*, Franklin Inst., Philadelphia, Pa.

(32) *Australian Mining and Engineering Review*, Melbourne, Vic., mth., 6d.

(33) *Transactions*, Am. Soc. C.E., New York City.

(34) *Bulletins*, Société des Ingénieurs Civils, Paris.

(35) *Mining Magazine*, 819 Salisbury House, London, E.C., mth., 1s.

(36) *Publications*, Iron and Steel Institute, London.

(37) *Proceedings*, Inst. of Mech. Eng., London.

(38) *Publications*, Field Columbian Museum, Chicago, U.S.A.

(39) *Journal*, Mining Society of Nova Scotia, Halifax, N.S.

(40) *Transactions*, Mining and Geological Institute of India, Calcutta.

(41) *Publications*, Department of Mines, Wellington, N.Z.

(42) *Journal*, Chamber of Mines of West Australia, Perth.

(43) *Journal of Industrial and Engineering Chemistry*, Easton, Pa.

(44) *Proceedings*, Geologists' Association, London.

LIST OF ARTICLES.

MECHANICAL.

Lubrication of Rock Drills. C. C. Phelps. (6) March 3, 1917.
Hard Stoking of Soft-Coal Boilers. (6) Feb. 24, 1917.
Hose Connections on Sinking Pumps. J. F. K. Brown. (6) March 17, 1917.
A Narrow-Gauge Alternating Current Mine Locomotive. R. W. Van Norden. (6) April 21, 1917.
Diesel Engines versus Steam Turbines for Mine Power Plants. (29) Bull., May, 1917.
Drill Bits and Drill Steel for Metal Mining. G. H. Gilman. (6) May 12, 1917.
Safety Door for Mine Cages. (6) May 19, 1917.
Electric Steel. (3) May 15, 1917.

METALLURGICAL.

Dry Concentration of Gold Ore. L. Goodday. (6) Feb. 17, 1917.
Ridge Mechanical Blende-Roasting Furnace. H. M. Ridge. (6) Feb. 17, 1917.
A Tube-Mill for Zinc Shorts. A. C. Daman. (6) Feb. 24, 1917.
Sodium Sulphate Precipitation at Nipissing. (6) March 3, 1917.
Tube-Mill Discharge Screen. A. W. Allen. (6) March 3, 1917.
Flotation in Rhodesia. (6) March 10, 1917.
Tube-Mill Practice in Rhodesia. A. W. Allen. (6) March 17, 1917.
Analysis of Aluminium Dust. J. E. Clennell. (6) March 24, 1917.
The Alaska Juneau Mill. (6) March 31, 1917.
Accurate Silica Determination in Commercial Analysis. F. G. Hawley. (6) March 31, 1917.
Hydraulic Flotation Machine. A. Crowfoot. (6) April 14, 1917.
Fairlie Process for Sulphuric Acid Manufacture. (6) April 21, 1917.
Percentage of Oil in Flotation. H. A. Megraw. (6) May 5, 1917.
Concentrating Canadian Molybdenite. (6) May 5, 1917.
Counter-Current Decantation System. A. Del Mar. (6) May 5, 1917.
Molybdenum Ores and their Concentration. F. W. Horton. (8) Feb. 24, 1917.
The Disposal of Flotation Products. R. S. Lewis. (8) April 7, 1917.
Sulphur Dioxide as a Flotative Agent. (8) April 7, 1917.
Sulphur from Pyrite. J. W. Beckman. (8) April 21, 1917.
Slime Agitation. R. Wheeler. (8) March 3, 1917.
An Improved System of Classification. J. M. Hyde. (8) April 28, 1917.
Beneficial Effect of Grinding with Steel Balls for Flotation. V. Zachert. (8) May 12, 1917.
The Theory of Ore Flotation. H. P. Corliss and C. L. Perkins. (43) May, 1917.
The Concentration of Sulphuric Acid. E. H. Armstrong. (43) April, 1917.
Sulphur from Pyrite. M. G. F. Sohnlein. (8) March 17, 1917.
Sulphur from Pyrite. E. H. Wedekind. (8) April 7, 1917.
Potash as a By-Product from the Blast Furnace. R. J. Wysor. (3) Feb. 15, 1917.
The Determination of Zinc. J. H. Hastings. (3) March 1, 1917.
Current Density in Copper Refining. L. Addicks. (3) March 15, 1917.
The Cottrell Process in Practice. L. Bradley. (3) March 15, 1917.
Some Studies in the Methods of Recovering Antimony from its Ores by Volatilization Processes. J. A. De Cew. (3) April 15, 1917.
Petrography as an Aid to Flotation. D. G. Campbell. (6) May 26, 1917.
Leaching of Low-Grade Copper Ores. J. Irving. (6) May 26, 1917.
Stope Measurement at Messina. Wm. Whyte. (25) Bull. No. 151.
The Tredinnick–Pattinson Process. W. E. Newnham. (25) Bull. No. 151.
A New Silicate of Lead and Zinc. P. A. Van Der Meulen. (29) Bull., May, 1917.
Calculations with Reference to the Use of Carbon in Modern American Blast Furnaces. (29) Bull., May, 1917.
Methods for Determining the Capacities of Slime-Thickening Tanks. R. T. Mishler. (29) Bull., March, 1917.
The Viscosity of Blast-Furnace Slag: Discussion. (29) Bull., March, 1917, also April, 1917.
The Magnetic Concentration of Low-Grade Ores: Discussion. (29) Bull., April, 1917.
Dry-Hot versus Cold-Wet Blast Furnace Gas Cleaning, and Some Suggestions Regarding Construction of Hot-Blast Stoves: Discussion. (29) Bull., April, 1917.
Notes on Flotation, 1916: Discussion. (29) Bull., April, 1917.

Tests on the Hardinge Conical Mill. H. F. Taggart. (29) Bull., April, 1917.
Non-Reversing Regenerative Furnace for Copper Smelting. W. G. Perkins. (8) June 2, 1917.
The Cascade Flotation Machine. C. R. Wilfley. (6) May 19, 1917.
Modern Concentration of Colorado Tungsten Ores. S. Fischer. (3) Serial commenced May 15, 1917.
Ore Treatment at the Perseverance Mine, Kalgoorlie, W.A. W. R. Cloutman. (35) April, 1917.
The Leaching of Copper Ores from Mount Coffin. J. D. Connor. (12) Metallurgical Report, No. 2.
Wet Gravity Concentration of Pyritic Ore from Nairne. J. D. Connor. (12) Metallurgical Report, No. 2.
The Milling of Barytes at Aldgate. J. D. Connor. (12) Metallurgical Report, No. 2.
The Treatment of Copper Ore from the Prince Albert Mine. J. D. Connor. (12) Metallurgical Report, No. 2.

MINING.

Shaft Winch for Supplies. C. F. Jackson. (4) March 24, 1917.
Unwatering an Inclined Shaft. J. E. Harding. (6) March 31, 1917.
Saving a Shrinkage Stope by an Electric Blast. S. F. Eaton. (6) March 31, 1917.
Methods of Underground Metal Mining. F. W. Sperr. (6) April 7, 1917.
The Colorado Top-Slicing Method. P. B. Scotland. (6) April 7, 1917.
Mining Methods Illustrated in Miniature. W. R. Crane. (6) April 7, 1917.
Mine Pumping Equipment. W. Symmes. (6) April 7, 1917.
Underground Churn Drilling at Old Dominion. G. N. Bjorge. (6) April 7, 1917.
Underground Tramming. D. B. Scott. (6) April 7, 1917.
Block-Caving System at Pewabic Mine, Michigan. (6) April 28, 1917.
Losses Incident to the Caving of Ore-Bodies. R. G. Sampson. (8) April 7, 1917.
Methods of Mining Big Ore-Bodies. R. A. Kinzie. (8) Serial commenced April 21, 1917.
Methods of Mining. (8) April 28, 1917.

MISCELLANEOUS.

Drill Sharpening Methods at the United Verde, Jerome, Arizona. F. Richards. (6) Feb. 17, 1917.
Chart for Finding Air Consumption of Drills. R. S. Lewis. (6) Feb. 24, 1917.
Common-sense of Gold Dredging. A. C. Ludlum. (6) Feb. 24, 1917.
Depreciation and Measurement of Expired Outlay on Plant. E. A. Erickson. (6) Serial commenced March 3, 1917.
An Ideal Change-House. F. M. Heidelberg. (6) March 3, 1917.
Metal Mining in Russia. S. H. Ball and B. Low. (6) March 10, 1917.
Chart for Obtaining the Velocity of Air. (6) March 10, 1917.
Laying Out Angles and Curves in Mine Work. (6) March 10, 1917.
Chart for Determining Flow Through Pipes. W. F. Schaphorst. (6) May. 5, 1917.
Effects of Faults on Richness of Ore. W. H. Storms. (8) March 31, 1917.
Electrical Precipitation in Metallurgical Plants. R. W. Kerns. (8) March 24, 1917.
Metallurgical Methods at Treadwell. S. B. Combest. (8) March 24, 1917.
The History of Flotation. T. A. Rickard. (8) Serial commenced March 17, 1917.
Hydro-Electric Power and Electrochemistry and Electrometallurgy in France. C. O. Mailloux. (3) Serial commenced March 1, 1917.
Exploration of Metalliferous Deposits. W. H. Emmons. (29) Bull., March, 1917.
Ore Deposits of the Boulder Batholith of Montana. P. Billingsley, A.B., A.M., and J. A. Grimes, E. M. Butte. (29) Bull., April, 1917.
Bucket Dredging for Tin in the Federated Malay States. H. D. Griffiths. (35) Serial commenced Dec., 1916.
The Shui-ko-Shan Zinc and Lead Mine in Hunan, Central China. A. S. Wheeler and S. Y. Li. (35) Feb., 1917.

PROCEEDINGS

OF THE

AUSTRALASIAN

Institute of Mining Engineers.

NEW SERIES.

No. 27.

EDITED BY THE SECRETARY.

This Institute is not responsible, as a body, for the facts and opinions advanced in any of its publications.

30th SEPTEMBER, 1917.

PUBLISHED QUARTERLY BY THE AUSTRALASIAN INSTITUTE OF MINING ENGINEERS, MELBOURNE.

Australasian Institute of Mining Engineers.

LIST OF OFFICERS, 1917.

President:

R. S. Black, W.A.

Vice-Presidents:

W. E. Wainwright, N.S.W. | D. B. Waters, Dunedin, N.Z.

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H. H. Schlapp	Victoria
Robert C. Sticht	Tasmania

Secretary:

D. L. Stirling, Melbourne, Vic.

Local Correspondents:

South Australia	Professor R. W. Chapman, Adelaide.
New South Wales	F. Danvers Power, Sydney.
Western Australia	F. W. R. Godden, Kalgoorlie.
New Zealand	D. B. Waters, Dunedin.
Tasmania	Russell M. Murray, Mount Lyell.
North Queensland	Murray Russell, Cloncurry.

Branch Secretaries:

Kalgoorlie	F. W. R. Godden, Ivanhoe Gold Corporation, Boulder, W.A.
Broken Hill	J. M. Bridge, c/o Zinc Corporation Ltd., Broken Hill, N.S.W.
Mount Morgan	B. G. Patterson, Mount Morgan, Q.

The Executive Committee consists of all Members of the Council residing, or for the time being, in Melbourne.

Head Office:

57-59 Swanston Street, Melbourne, Victoria.

Institute Matters.

CONTENTS.

	Page
MINUTES OF MEETINGS—	
Of the Executive Committee	liii
NOTICES	lv
PUBLICATIONS—Added to Library	lviii
RECENT ARTICLES—On Mining Matters	lx

MINUTES OF MEETINGS.

OF THE EXECUTIVE COMMITTEE.

(Summary).

JULY 30TH, 1917—1 P.M.

The Secretary's report was presented and accounts to the amount of £23 were passed for payment.

The following were admitted to the Institute :—As Member—Mr. Gilbert Rigg. As Associate Member—Mr. Harry Jackson Myles.

Resignation of Mr. W. H. Jowett was submitted and accepted.

An invitation from the Melbourne Chamber of Commerce for the Institute to appoint arbitrators under the Voluntary Tribunals of Arbitration of the Associated Chambers of Commerce was submitted. Resolved that the matter was outside the province of the Institute.

A letter from the Engineering Association of New South Wales offering Members of the Institute the privilege of the use of its library was submitted and the offer accepted with thanks. It was resolved that the Institute offer the Association reciprocal privileges.

A Paper entitled "Notes on the Phillips River Gold and Copper Field" by M. R. M'Keown was submitted and referred to the Publication Committee.

AUGUST 27TH, 1917—1 P.M.

The Secretary's report was presented and accounts to the amount of £40 were passed for payment.

Nomination of Mr. Kenzo Ikeda as a Member was submitted and approved.

Resolved that the First Ordinary Meeting, 1917, be held in Melbourne on 26th November, at 12.30 p.m.

A suggestion from the Broken Hill Branch regarding Incorporation was received and directions given for copies to be supplied to Members of Council.

SEPTEMBER 24TH, 1917—1 P.M.

The Secretary's report was presented and accounts to the amount of £41, including printing, £15, were passed for payment.

Nomination of Mr. Frank Fancett Espie as a Member was approved.

Paper entitled "Some Notes on the Westonia Goldfield, Western Australia, with Special Reference to the New Method of Controlling Underground Water adopted in the Edna May Deep Levels Gold Mine," by N. S. Stuckey, was submitted and referred to the Publication Committee.

The subject of Incorporation was discussed and further consideration deferred pending receipt of expressions of opinion from Members of Council in the various States.

Resolved that the Annual Meeting be held on 21st January, at 1 p.m.

Other routine business was transacted.

NOTICES.

The rooms of the Institute are open from 9.30 A.M. to 10 P.M. daily, except Sundays and Public Holidays.

MEMBERSHIP.

Applications for admission to the Institute have been received from the following and are now submitted to Members for confidential report :—As Members—Frank Fancett Espie, Burma Mines Ltd., Bawdwin, Upper Burma, and Kenzo Ikeda, c o Fujita & Co., Osaka, Japan.

Since the last issue of Proceedings the following have been admitted to the Institute :—

MEMBER.

Names and Addresses.

Rigg, Gilbert, c/o Broken Hill Associated Smelters, Collins House, 360 Collins Street, Melbourne.

ASSOCIATE MEMBER.

Myles, Henry Jackson, Inspector of Mines, Cloncurry, Q.

PUBLICATIONS.

Included in this issue is a paper entitled "Notes on the Phillips River Gold and Copper Field" by Mr. M. R. M'Keown. Discussion is invited thereon.

Members are earnestly invited to forward contributions on subjects of interest on Mining, Metallurgy, etc. for publication in the Proceedings. Suggestions regarding subjects for papers would be appreciated.

FIRST ORDINARY MEETING, 1917.

The First Ordinary Meeting, 1917, will be held at the Institute rooms, Melbourne, on 26th November, 1917, at 12.30 p.m.

USE OF LIBRARY.

The Engineering Association of New South Wales has kindly offered Members of the Institute the privilege of the use of its Library. This offer has been accepted and reciprocal privileges extended.

ON ACTIVE SERVICE.

The following Members have reported their enlistment since the last issue of Proceedings:—

Anderson, A. G., recently engaged at the Broken Hill Pty. Steel Works, Newcastle, N.S.W.

Newman, J. Malcolm, recently managing director of the Larut Tin Dredging Co., Fed. Malay States.

Rabling, Harold, recently metallurgist, St. Joseph Lead Co., Bonne Terre, Mo., U.S.A.

Honor Won.

Captain Kenneth Audrey Mickle of the Royal Garrison Artillery, formerly of Melbourne, has been awarded the D.S.O. Captain Mickle was, prior to his enlistment, chief chemist at the Burma Mines Ltd., Upper Burma. He was educated at Queen's College, St. Kilda, and for three years carried out research work at the Melbourne University. Captain Mickle had command of the 9th Division Trench Mortar Brigade. Some months ago he was promoted to Captain for bravery in the field, and in June last was mentioned in despatches.

Killed in Action.

Word has come to hand that A. M. Hogarth, late of Cloncurry, Queensland, was killed in action in France in 1916.

Wounded.

Lieut. E. P. Hargraves of "C" Company Tunnelling Corps has been reported wounded.

MOVEMENTS OF MEMBERS.

Kenneth C. Church, late of Mt. Elliott Ltd., is now in Melbourne.

G. A. Denny is now in Sydney after an absence of twenty-seven years from Australia. He has just accepted an invitation from the Home Government to join the staff of the Ministry of Munitions and is leaving by the first available steamer to take charge of a large new munitions factory. His address will be c/o The Royal Society's Club, St. James Street, London.

A. J. King of the Kampong Kamunting Tin Dredging Co., has been in Australia for a few months on leave and has just returned to the Fed. Malay States.

W. A. Macleod is now in the London office of Bewick Moreing & Co.

Arthur H. P. Moline, late manager of Cock's Pioneer Gold & Tin Mines, Eldorado, has been appointed mine superintendent of the Bendigo Amalgamated Goldfields, N.L.

John W. Moule is now metallurgist to the Great Cobar Ltd., Cobar, N.S.W.

Engineer-Lieut. J. W. Wishart, R.A.N. is on H.M.A.S. Sydney somewhere in the North sea.

ANNUAL MEETING, 1918.

The Annual Meeting, 1918, will be held at the rooms, 57-59 Swanston Street, Melbourne, on Monday, 21st January, 1918, at 1 p.m. The business of the meeting will include the presentation of the Annual Report and Balance Sheet for 1917, and the election of officers to fill the annual vacancies. The officers retiring are :—President, Mr. R. S. Black; Vice-President, Professor D. B. Waters; Councillors, Messrs. E. G. Banks, W. H. Corbould, C. F. Courtney, H. Lipson Hancock, H. Herman, J. W. Moule and Professor E. W. Skeats. Nominations to fill the vacancies thus occurring should reach the Secretary forty days before the Annual Meeting.

LIST OF PUBLICATIONS ADDED TO THE LIBRARY

From 30th June, 1917, to 30th September, 1917.

Australian Mining Standard	weekly	Melbourne
Australian Mining and Engineering Review	monthly	Melbourne
Engineering and Mining Journal	weekly	New York
Iron and Coal Trades Review	weekly	London
Mining Journal	weekly	London
Mining and Scientific Press	weekly	San Francisco
The Colliery Engineer	monthly	Scranton, Pa.
Mining and Engineering World	weekly	Chicago
Mining Magazine	monthly	London
Indian Engineering	weekly	Calcutta
Chemical News	weekly	London
South African Engineering	monthly	London
Journal of Industrial and Engineering Chemistry	monthly	Easton, Pa.
Society of Chemical Industry: Journal	bi-monthly	London
Chemical, Metallurgical and Mining Society of South Africa: Journal	monthly	Johannesburg
Franklin Institute: Journal	bi-monthly	Philadelphia
Institution of Mechanical Engineers: Journal	monthly	London
Metallurgical and Chemical Engineering	monthly	New York
Chamber of Mines of Victoria: Monthly Mining Report		Melbourne
Chamber of Mines of Western Australia: Journal	monthly	Kalgoorlie
The West Australian Mining, Building and Engineering Journal	weekly	Perth
Queensland Department of Mines: Government Mining Journal	monthly	Brisbane
Transvaal Chamber of Mines: Monthly Analysis of Production		Johannesburg
Rhodesia Chamber of Mines: Report of Executive	monthly	Bulawayo
Government Statist: Victorian Year Book 1916-17, Parts 1 and 2		Melbourne

Department of Mines, New South Wales:
Mineral Resources, Nos. 25 and 26 - - Sydney
Northern Engineering Institute of New South Wales:
The Economic Use of Coal By-Products by J. Paton
The Utilization of Exhaust Steam by R. H. Barr - Newcastle
Royal Society of Queensland:
Proceedings, Vol. XXVIII. - - Brisbane
South School of Mines and Industries:
Annual Report 1916 and Prospectus 1917 - Adelaide
Department of Mines, Western Australia:
Annual Progress Report of Geological Survey, 1916
Bulletin, No. 72 - - - - Perth
Department of Mines, Tasmania:
Mineral Resources, Nos. 2-4 - - - Hobart
Institute of Chemistry of Great Britain and Ireland:
Proceedings, 1917. Part II. - - - London
Institution of Mining Engineers:
Transactions, Vol. LII., Part 5 - - London
Department of Mines and Geology, Mysore:
Records, Vol. XV., 1916. Part 1 - - Bangalore
Société Des Ingenieurs Civils De France:
Proceedings, No. 5 - - - - Paris
Annales des Mines:
Vol. VI., Pages 1-76 - - - Paris
Societa Geologica Italiana:
Bulletin, Vol. XXXV., (1916) Part 3 - Rome
Department of Mines, Canada:
Memoirs, Nos. 88, 93, 94, 97
Bulletins, Nos. 14, 17
Museum Bulletin, No. 25
Report on Building and Ornamental Stones, Vol. IV. - - - - Ottawa
Canadian Mining Institute:
Transactions, Vol. XIX. - - - Montreal
Ontario Bureau of Mines:
Twenty-fifth Annual Report, Vol. XXV., Part 1 Toronto
Columbia University:
Bulletin, 17th Series, Nos. 2, 4, 6, 7, 9, 11, 16, 17 New York

RECENT ARTICLES ON MINING MATTERS.

(30th June, 1917, to 30th September, 1917).

NOTE.—*This list is prepared for the purpose of placing before members the titles of the more important papers appearing in the usual publications concerned with mining engineering, metallurgy, &c., due regard being had to Australasian requirements.*

LIST OF PUBLICATIONS.

References are given by the number prefixed to each publication in the attached list. Wk., weekly; mth., monthly.

(1) *The Australian Mining Standard*, Melbourne, Victoria, wk., 6d.

(2) *The Queensland Government Mining Journal*, Brisbane, mth., 6d.

(3) *Metallurgical and Chemical Engineering*, New York, mth., 25c.

(4) *The Mining Journal*, London, E.C., wk. 6d.

(5) *Mining and Engineering World*, Chicago, wk., 10c.

(6) *The Engineering and Mining Journal*, New York, wk., 15c.

(7) *The Colliery Engineer*, Scranton, Pa., U.S.A., mth., 20c.

(8) *Mining and Scientific Press*, San Francisco, Cal., wk., 10c.

(9) *Annales des Mines*, Paris, France, mth.

(10) *Publications*, Department of Mines, Melbourne, Victoria.

(11) *Publications*, Department of Mines, Sydney, New South Wales.

(12) *Publications*, Department of Mines, Adelaide, South Australia

(13) *Publications*, Department of Mines, Brisbane, Queensland.

(14) *Publications*, Department of Mines, Perth, Western Australia.

(15) *Publications*, Department of Mines, Hobart, Tasmania.

(16) *Publications*, Geological Survey, Canada, Ottawa, Ontario.

(17) *Publications*, Bureau of Mines, Toronto, Ontario.

(18) *Publications*, Geological Survey of India, Calcutta.

(19) *Publications*, Geological Survey, U.S.A., Washington.

(20) *Publications*, Geological Survey, Alabama, Montgomery, Ala.

(21) *Publications*, California State Mining Bureau, Sacramento, Cal.

(22) *Reports* Aust. Assoc. Adv. Science, Sydney, New South Wales.

(23) *Transactions and Proceedings*, New Zealand Inst., Wellington, New Zealand.

(24) *Quarterly Journal*, Geological Society, London.

(25) *Transactions*, Inst. Mining and Metallurgy, London, E.C.

(26) *Transactions*, Inst. Min. Eng., London.

(27) *Journal*, Canadian Mining Inst., Ottawa, Ontario.

(28) *Journal*, Chem., Min., and Met. Soc. of S.A., Johannesburg, Transvaal.

(29) *Transactions*, Am. Inst. of Min. Eng., New York City.

(30) *Proceedings*, Colorado Scientific Soc., Denver, Col.

(31) *Journal*, Franklin Inst., Philadelphia, Pa.

(32) *Australian Mining and Engineering Review*, Melbourne, Vic., mth., 6d.

(33) *Transactions*, Am. Soc. C.E., New York City.

(34) *Bulletins*, Société des Ingénieurs Civils, Paris.

(35) *Mining Magazine*, 819 Salisbury House, London, E.C., mth., 1s.

(36) *Publications*, Iron and Steel Institute, London.

(37) *Proceedings*. Inst. of Mech. Eng., London.

(38) *Publications*, Field Columbian Museum, Chicago, U.S.A.

(39) *Journal*, Mining Society of Nova Scotia, Halifax, N.S.

(40) *Transactions*, Mining and Geological Institute of India, Calcutta.

(41) *Publications*, Department of Mines, Wellington, N.Z.

(42) *Journal*, Chamber of Mines of West Australia, Perth.

(43) *Journal of Industrial and Engineering Chemistry*, Easton, Pa.

(44) *Proceedings*, Geologists' Association, London.

LIST OF ARTICLES

MECHANICAL.

Drill Bits and Drill Steel for Metal Mining. G. H. Gilman. (6) July 28, 1917.
The Selection of Gearing. W. H. Phillips. (6) July 28, 1917.
Drill Sharpening. (8) May 26, 1917.
Notes on Compression and Transmission of Air. R. S. Lewis. (8) June 9, 1917.
Comparative Tests of Hammer Drill Bits. C. R. Forbes and J. C. Barton. (29) Bull. No. 128.
Notes on the Construction of Turbine Pumps. A. E. L. Chorlton. (37) July, 1917.

METALLURGICAL.

Cyaniding at Comacaran Mines, Central America. W. M. D'Arcy. (6) June 2, 1917.
Metallurgy of Ferro-Manganese. R. J. Anderson. (6) June 2, 1917.
Pneumatic Concentrator and Amalgamator. F. A. Stanley. (6) June 9, 1917.
Riffles on Concentrating Tables. A. Del Mar. (6) June 9, 1917.
The Proposed Corocoro Mill, Bolivia. M. R. Lamb. (6) June 16, 1917.
Laws of Distribution of Lead in South-East Missouri Ores. S. Bagnard. (6) June 16, 1917.
Determining Flourine in Soluble Flourides. (6) June 16, 1917.
Tube Mill Discharge Screen. A. W. Allen. (6) June 16, 1917.
The Metallurgy of Ferrosilicon. (6) June 23, 1917.
Phosphoric Acid Determination in Phosphate Rock. C. C. Semple. (6) June 30, 1917.
An Ore-Testing Laboratory. C. J. Trauerman. (6) June 30, 1917.
Copper Smelting at Santa Lucia. F. C. Lincoln. (6) July 7, 1917.
Ammonia Leaching of Calumet Tailings. C. H. Benedict. (6) July 14, 1917.
Inhibitory Films in Flotation. W. H. Coghill. (6) July 14, 1917.
Oil Concentration of Lead Concentrate at Darwin, California. H. S. Rexworthy. (6) July 14, 1917.
Solution of Grinding Problems. S. Bagnard. (6) July 14, 1917.
Selective Lead-Zinc Flotation. L. L. Kirtley. (6) July 14, 1917.
Concentration at Humboldt, Arizona. G. M. Colvocoresses. (6) July 14, 1917.
The Burro Mountain Concentrator. F. C. Blickensderfer. (6) July 14, 1917.
Milling Wisconsin Lead-Zinc Ores. W. Shultz. (6) July 14, 1917.
Continuous Drum Filters. C. J. Trauerman. (6) July 14, 1917.
Efficiency of Screens. H. Rabling. (6) July 14, 1917.
Sulphatizing with Weak Sulphurous Gases. G. C. Westby. (6) July 21, 1917.
Sampling and Analyzing Zinc Ores and Products. J. H. Hastings. (6) July 28, 1917.
The Potter Process at Broken Hill, Australia. W. E. Simpson. (8) May 26, 1917.
Method of Treating Impure Tungsten Ore. L. S. Ropes. (8) June 9, 1917.
The Empirical Formula in Milling Control. A. J. Sale. (8) June 30, 1917.
Principles of Flotation. T. A. Rickard. (8) Serial commenced July 7, 1917.
Formation of Zinc Ferrate. E. H. Hamilton, G. Murray, and D. M'Intosh. (8) Aug. 11, 1917.
Flotation Tests on Gold Ores. E. Joyce. (8) Aug. 11, 1917.
Launder Flotation Machine. B. M. Snyder. (8) Aug. 11, 1917.
Notes on the Hydrometallurgical and Electrolytic Treatment of Zinc Ore. E. E. Watts. (3) June 1, 1917.
Chemical Reactions of Iron Smelting. W. Mathesius. (3) June 1, 1917.
Leads for Electric Furnaces. Prof. A. Lindstrom. (3) June 15, 1917.
Impurities in Electrolytic Copper Refining. L. Addicks. (3) June 15, 1917.
The Electrometric Titration of Zinc. R. V. Bichowsky. (43) July, 1917.
Leaching of Copper Ores at Bisbee, Arizona. J. Irving. (25) Bull. No. 153.
A Standard Screen Scale for Testing Sieves. (29) Bull. No. 125.
Influence of Base Metals in Gold Bullion Assaying. F. P. Dewey. (29) Bull. No. 127.
The Metallurgy of Lead Ores in the Lower Mississippi Valley. H. Garlicks. (29) Bull. No 127.
The Hancock Jig in the Concentration of Lead Ores. Harold Rabling. (29) Bull. No. 128.
Electric Smelting of Copper Ores. W. Dewar. (35) June, 1917.

Control of Emulsions in Flotation. C. De Kalb. (8) Aug. 18, 1917.
Copper Precipitating Plant at Balaklala Mine. S. A. Hohman. (8) Aug. 18, 1917.
Chemical Engineering Aspect of Renovating a Sulphide Mill. H. K. Moore. (3) Aug. 1, 1917.
Operating Details of Zinc Retort Furnaces. E. M. Johnson. (3) Aug. 1, 1917.
By-Products in Electrolytic Copper Refining. L. Addicks. (3) Aug. 15, 1917.
Flotation of Gold and Silver Mineral. T. A. Rickard. (8) Aug. 25, 1917.
Hydro-Metallurgy of Lead-Silver at the Bunker Hill Smelter. C. L. Larson. (8) Aug. 25, 1917.

MINING.

Safety Device for Incline Shafts. R. J. Sampson. (6) June 9, 1917.
Mining Problems on the Rand. H. Foster Bain. (8) May 26, 1917.
Automatic Skips in Shaft with Rope Guides. H. V. Wallace. (8) June 23, 1917.
Timbering in Deep Placer Mining. H. T. Power. (8) Aug. 11, 1917.
Australian Practice in Pump-Dredging. A. H. P. Moline. (35) July, 1917.
Hydraulic Sluicing for Gold and Tin. A. H. P. Moline. (32) Sept. 5, 1917.

MISCELLANEOUS.

Occurrence and Utilization of Antimony Ores. (6) June 9, 1917.
The Clarification of Mill Water. (6) June 16, 1917.
California Dredge with Four Tailings Conveyors. L. H. Eddy. (6) June 23, 1917.
Proposed Rejuvenation of Bendigo. (6) June 23, 1917.
Equivalent Cost of Coal and Oil as Fuel. R. L. Wales. (6) June 30, 1917.
The Determination of Silica. H. A. B. Motherwell. (6) June 30, 1917.
Hints About Mill Lighting. A. L. Powell. (6) July 14, 1917.
Magmatic Segregation and Ore Bodies. J. T. Singewald. (8) May 26, 1917.
Sampling Low-Grade Ore-Bodies. W. J. Loring. (8) June 9, 1917.
Survey of Inclines Without Auxiliaries. A. J. Sale. (8) July 21, 1917.
Mill Tests *v.* Hand Sampling in Valuing Mines. M. Webber. (8) July 28, 1917.
Producer Gas and its Industrial Uses. F. W. Steere. (3) June 15, 1917.
Results of Recent Investigations of the Smelter Smoke Problem. A. E. Wells. (43) July, 1917.
Shall Great Britain and America Adopt the Metric System? W. R. Ingalls. (25) Bull. No. 152.
Graphic Solutions of Some Compressed Air Calculators. C. W. Crispell. (29) Bull. No. 126.
The Construction and Maintenance of Slime Dams. J. E. Thomas and E. A. Osterloh. (28) June, 1917.
Some Notes on Explosions of Fire Damp, and Occurrences of Gob Fires in Natal. J. E. Vaughan and F. A. Steart. (28) June, 1917.
Cement Materials at Flowery Gully. W. H. Twelvetrees. (15) Mineral Resources, No. 2.
Phosphate Deposits in Tasmania. W. H. Twelvetrees. (15) Mineral Resources, No. 3.
Asbestos at Anderson's Creek. W. H. Twelvetrees. (15) Mineral Resources, No. 4.
Condensation of Water at Coolgardie, Western Australia. L. Goodday. (6) Aug. 11, 1917.
Use and Testing of Oxygen Mine-Rescue Apparatus. (8) Aug. 18, 1917.

PROCEEDINGS

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AUSTRALASIAN

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NEW SERIES.

No. 28.

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31st DECEMBER, 1917.

PUBLISHED QUARTERLY BY THE AUSTRALASIAN INSTITUTE OF MINING ENGINEERS, MELBOURNE.

Australasian Institute of Mining Engineers.

LIST OF OFFICERS, 1917.

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Vice-Presidents:

W. E. Wainwright, N.S.W. | D. B. Waters, N.Z.

R. W. Chapman, S.A.

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W. H. Corbould	Queensland
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John W. Moule	Queensland
G. D. Delprat	New South Wales
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Geo H. Broome	Victoria
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Lindesay C. Clark	Tasmania
H. H. Schlapp	Victoria
Robert C. Sticht	Tasmania

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D. L. Stirling, Melbourne, Vic.

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New South Wales	F. Danvers Power, Sydney.
Western Australia	F. W. R. Godden, Kalgoorlie.
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North Queensland	Murray Russell, Cloncurry.

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Head Office:

57-59 Swanston Street, Melbourne, Victoria.

Institute Matters.

CONTENTS.

MINUTES OF MEETINGS— Page

Of the Institute - - - - - - lxiii

Of the Executive Committee - - - - lxiii

NOTICES - - - - - - - - lxv

PUBLICATIONS—Added to Library - - - - - lxvii

RECENT ARTICLES—On Mining Matters - - - - lxx

MINUTES OF MEETINGS.

OF THE INSTITUTE.

NOVEMBER 26TH, 1917—1 P.M.

The Minutes of the Annual Meeting, 1917, were taken as read and confirmed.

OF THE EXECUTIVE COMMITTEE.

(Summary).

OCTOBER 29TH, 1917—1 P.M.

The Secretary's report was presented and accounts to the amount of £38 were passed for payment.

Applications for admission to the Institute were received, from Messrs. J. F. Hall and A. S. Winter (as Members), and Mr. Philip A'Morley Parker (as Associate Member) and approved.

Resignation of Mr. A. D. Gilchrist was accepted.

A Paper entitled "The Divining Rod" by Mr. G. D. Reid was referred to the Publication Committee.

Resolved that the contribution entitled "Some Notes on the Australian Molybdate Method of Assay for Lead" be referred to the Broken Hill Branch.

The question of Incorporation of the Institute was again discussed and it was resolved that the Solicitor-General for the Commonwealth be requested to bring in a small bill to provide for such incorporation under the Commonwealth.

The Institute representatives on the Joint Rooms Committee were authorized to act in regard to the renewal of the lease of rooms.

NOVEMBER 26TH, 1917—1 P.M.

The Secretary's report was presented and accounts to the amount of £61, including printing, £39, were passed for payment.

Resolved that Members on munition work be not required to pay subscriptions whilst so engaged.

A letter was submitted from the South Australian Institute of Engineers suggesting the formation of an Australian Institute of Engineers and recommending the holding of an Interstate Conference to discuss the proposal. Resolved that the question be brought before Members at the Annual Meeting in January, 1918; that the South Australian Institute be informed that the Council was of opinion that a Federation of the existing Institutes appeared preferable to an amalgamation, but would be pleased to appoint delegates to attend the proposed Conference.

It was resolved that a Sub-Committee be appointed to prepare a list of practising Members of the Institute; this list to be supplied to the Federal Government in the event of the Institute's previous recommendation, regarding signatures to reports by qualified mining engineers only, being adopted.

Other routine business was transacted.

NOTICES.

The rooms of the Institute are open from 9.30 A.M. to 10 P.M. daily, except Sundays and Public Holidays.

MEMBERSHIP.

Applications for admission to the Institute have been received from the following and are now submitted to Members for confidential report :—Members—John Frederick Hall. Queen Street, Brisbane, Q., John Joice, Leonora Gold Blocks N.L., Leonora, W.A.; Arthur S. Winter, Mouramba Copper Mines Ltd., Nymagee, N.S.W. Associate Member—Philip A'Morley Parker, 25 Victoria Street, London.

PUBLICATIONS.

Included in this issue is a paper by Mr. N. S. Stuckey entitled "Some Notes on the Westonia Gold Field, Western Australia, with special reference to the New Method of Controlling Underground Water adopted in the Edna May Deep Levels Gold Mine."

Discussion is invited thereon.

ANNUAL MEETING, 1918.

Members are reminded that the Annual Meeting, 1918, will be held at the Institute rooms, on 21st January, 1918, at 1 p.m., when the Annual Report and Balance Sheet will be presented and nomination of officers to fill the annual vacancies recorded. Nominations received are as follows :—President, Mr. J. W. Sutherland; Vice-President, Professor D. B. Waters; Council, Messrs. E. G. Banks, W. H. Corbould, C. F. Courtney, H. Lipson Hancock, H. Herman, J. W. Moule and Professor E. W. Skeats. As the nominations received are not in excess of the vacancies a ballot will not be necessary. A suggestion to hold an Interstate Conference to discuss the proposal to federate or amalgamate all Australian Institutes will also be discussed.

ENGINEERING ASSOCIATION OF N.S.W.

The Engineering Association of New South Wales has courteously extended the privileges of full membership to any Members of the Australasian Institute of Mining Engineers who may at any time be visiting Sydney. This offer has been gratefully accepted and reciprocal privileges extended on behalf of the Institute.

ON ACTIVE SERVICE.

The following Members have reported their enlistment since the last issue of Proceedings:—

FOSTER, DONALD, Belmont, Sutton-Surrey, England.

OSBORNE, G. W., Meekatharra, W.A.

ROSS, C. N., The University, Brisbane, Q.

TAYLOR, A. S., Rockdale, N.S.W.

Honors Won.

Capt. W. J. Rose, late of the Amalgamated Zinc (De Bavey's Ltd.), Broken Hill, N.S.W., has been awarded the Military Cross.

G. H. T. Best, late of the Sons of Gwalia Mine, Leonora, N.S.W., has also been decorated with the Military Cross.

Killed in Action.

Members will regret to learn that Captain James Peat, late Chief Surveyor on the Ivanhoe Gold Corporation, Boulder, W.A., has been killed in action at the front. He sailed with the first convoy and went through a course of training in Egypt. Just prior to the landing on Gallipoli he contracted a severe attack of blood poisoning, which lasted 12 months, after recovery he left with the 44th Battalion and was killed in France.

LIST OF PUBLICATIONS ADDED TO THE LIBRARY

From 30th September, 1917, to 31st December, 1917.

Australian Mining Standard - -	weekly -	Melbourne
Australian Mining and Engineering Review	monthly -	Melbourne
Engineering and Mining Journal - -	weekly -	New York
Iron and Coal Trades Review - -	weekly -	London
Mining Journal - - - -	weekly -	London
Mining and Scientific Press - -	weekly -	San Francisco
The Colliery Engineer - - -	monthly -	Scranton, Pa.
Mining and Engineering World - -	weekly -	Chicago
Mining Magazine - - -	monthly -	London
Indian Engineering - - -	weekly -	Calcutta
Chemical News - - - -	weekly -	London
South African Engineering - -	monthly -	London
Journal of Industrial and Engineering Chemistry - - -	monthly -	Easton, Pa.
Society of Chemical Industry : Journal -	bi-monthly	London
Chemical, Metallurgical and Mining Society of South Africa : Journal - -	monthly -	Johannesburg
Franklin Institute : Journal - -	bi-monthly	Philadelphia
Institution of Mechanical Engineers : Journal	monthly	London
Metallurgical and Chemical Engineering -	monthly -	New York
Chamber of Mines of Victoria : Monthly Mining Report - -	-	Melbourne
Chamber of Mines of Western Australia : Journal - -	monthly -	Kalgoorlie
The West Australian Mining, Building and Engineering Journal - - -	weekly -	Perth
Queensland Department of Mines : Government Mining Journal - -	monthly -	Brisbane
Transvaal Chamber of Mines : Monthly Analysis of Production -	-	Johannesburg
Rhodesia Chamber of Mines : Report of Executive - - -	monthly -	Bulawayo
Royal Society of Victoria : Proceedings, Vol. XXX., Part I. -	-	Melbourne

Engineering Association of New South Wales :	
Presidential Address, 1917 - -	Sydney
Northern Engineering Institute of New South Wales :	
Watertight Bulkheads and Tanks in Ship Construction, by F. A. Spence - -	Newcastle
Royal Society of New South Wales :	
Journal and Proceedings, Vol. I., Parts 1-3 -	Sydney
University of Sydney :	
Calendar for 1917 - - - -	Sydney
Department of Mines, Queensland :	
Geological Survey, Publications, No. 259 and 260	Brisbane
Department of Mines, South Australia :	
Review of Mining Operations, half-year ending 30/6/17	Adelaide
School of Mines of South Australia :	
Prospectus, 1917 - - - -	Adelaide
Department of Mines, Western Australia :	
Annual Report, 1916 - - -	Perth
Department of Mines, Tasmania :	
Annual Report, 1916 - - -	Hobart
Department of Mines, New Zealand :	
Mines Statements, 1916	
Palæontological Bulletin No. 4 - -	Wellington
Institution of Mining and Metallurgy :	
Bulletins, No. 155 and 156 - - -	London
Institute of Chemistry of Great Britain and Ireland :	
Proceedings, 1917, Part III. - -	London
Geological Society :	
Quarterly Journal, No. 286	
List of Members, 1917 - - -	London
Iron and Steel Institute :	
Journal, No. 1, 1917 - - -	London
Institution of Mining Engineers :	
Transactions. Vol. LIII., Part 4 ; Vol. LIV., Part 1	London
Geological Survey of India :	
Records, Vol. XLVIII., Parts 1 and 2 -	Calcutta
Société Des Ingenieurs Civils De France :	
Bulletin, January-April, 1917 - -	Paris
Annales des Mines :	
Vol. VI. - - - - -	Paris

Mining and Geological Institute of India :	
Transactions, Vol. XI., Parts 1 and 2 -	Calcutta
Department of Mines, Canada :	
Bulletin, No. 15	
Memoirs, Nos. 84, 87 and 98	
Summary Report of Geological Survey, 1916 -	Ottawa
Bureau of Mines, Ontario :	
Annual Report, Vol. XXV., Parts 2 and 3 -	Toronto
American Institute of Mining Engineers :	
Bulletins, No. 129 and 130 - - -	New York
Columbia University :	
Bulletins, Nos. 10, 15, 17, 25, 27, 28 and 32 -	New York
United States Geological Survey :	
Professsonal Papers, Nos. 91, 98I, 98J, 98K, 98M and 98N	
Water Supply Papers, Nos. 360, 384, 387 and 395	
Bulletins Nos. 627-649	
Mineral Resources, Various Papers, Part I., Nos. 1-7 : Part II., Nos. 12-20 - -	Washington
Department of Mines, Mexico :	
Bulletin, Vol. IV., No. 1 - - -	Mexico

RECENT ARTICLES ON MINING MATTERS.

(30th September, 1917, to 31st December, 1917).

NOTE.—*This list is prepared for the purpose of placing before members the titles of the more important papers appearing in the usual publications concerned with mining engineering, metallurgy, &c., due regard being had to Australasian requirements.*

LIST OF PUBLICATIONS.

References are given by the number prefixed to each publication in the attached list. Wk., weekly; mth., monthly.

(1) *The Australian Mining Standard*, Melbourne, Victoria, wk., 6d.

(2) *The Queensland Government Mining Journal*, Brisbane, mth., 6d.

(3) *Metallurgical and Chemical Engineering*, New York, mth., 25c.

(4) *The Mining Journal*, London, E.C., wk. 6d.

(5) *Mining and Engineering World*, Chicago, wk., 10c.

(6) *The Engineering and Mining Journal*, New York, wk., 15c.

(7) *The Colliery Engineer*, Scranton, Pa., U.S.A., mth., 20c.

(8) *Mining and Scientific Press*, San Francisco, Cal., wk., 10c.

(9) *Annales des Mines*, Paris, France, mth.

(10) *Publications*, Department of Mines, Melbourne, Victoria.

(11) *Publications*, Department of Mines, Sydney, New South Wales.

(12) *Publications*, Department of Mines, Adelaide, South Australia.

(13) *Publications*, Department of Mines, Brisbane, Queensland.

(14) *Publications*, Department of Mines, Perth, Western Australia.

(15) *Publications*, Department of Mines, Hobart, Tasmania.

(16) *Publications*, Geological Survey, Canada, Ottawa, Ontario.

(17) *Publications*, Bureau of Mines, Toronto, Ontario.

(18) *Publications*, Geological Survey of India, Calcutta.

(19) *Publications*, Geological Survey, U.S.A., Washington.

(20) *Publications*, Geological Survey, Alabama, Montgomery, Ala.

(21) *Publications*, California State Mining Bureau, Sacramento, Cal.

(22) *Reports* Aust. Assoc. Adv. Science Sydney, New South Wales.

(23) *Transactions and Proceedings*, New Zealand Inst., Wellington, New Zealand.

(24) *Quarterly Journal*, Geological Society, London.

(25) *Transactions*, Inst. Mining and Metallurgy, London, E.C.

(26) *Transactions*, Inst. Min. Eng., London.

(27) *Journal*, Canadian Mining Inst., Ottawa, Ontario.

(28) *Journal*, Chem., Min., and Met. Soc. of S.A., Johannesburg, Transvaal.

(29) *Transactions*, Am. Inst. of Min. Eng., New York City.

(30) *Proceedings*, Colorado Scientific Soc., Denver, Col.

(31) *Journal*, Franklin Inst., Philadelphia, Pa.

(32) *Australian Mining and Engineering Review* Melbourne, Vic., mth., 6d.

(33) *Transactions*, Am. Soc. C.E., New York City.

(34) *Bulletins*, Société des Ingénieurs Civils, Paris.

(35) *Mining Magazine*, 819 Salisbury House, London, E.C., mth., 1s.

(36) *Publications*, Iron and Steel Institute, London.

(37) *Proceedings*, Inst. of Mech. Eng., London.

(38) *Publications*, Field Columbian Museum Chicago, U.S.A.

(39) *Journal*, Mining Society of Nova Scotia, Halifax, N.S.

(40) *Transactions*, Mining and Geological Institute of India, Calcutta.

(41) *Publications*, Department of Mines, Wellington, N.Z.

(42) *Journal*, Chamber of Mines of West Australia, Perth.

(43) *Journal of Industrial and Engineering Chemistry*, Easton, Pa.

(44) *Proceedings*, Geologists' Association, London.

LIST OF ARTICLES.

MECHANICAL.

Testing and Recording the Efficiency of Drills. H. H. Hodgkinson. (6) Sept. 8, 1917.
Underground Drill Rack. (6) Sept. 8, 1917.
Ideal Shop for Sharpening Drill Steel. G. H. Gilman. (6) Oct. 6, 1917.
Mechanical Ventilation for Metal Mines. George Rice. (8) Oct. 20, 1917.
Electric Furnace Manufacture of Shoes and Dies on the Witwatersrand. G. H. Stanley. (28) Sept., 1917.

METALLURGICAL.

Recovery of Pyrite from Coal. (6) Sept. 22, 1917.
Some Fluxes and Methods Used in Fire Assays. Carl J. Trauerman. (6) Sept. 22, 1917.
Present Milling Practice of the Joplin District. T. Chapman. (6) Oct. 6, 1917.
The Granby Mine at Anyox, B.C. W. A. Williams. (6) Oct. 13, 1917.
Development of Copper Converting. M. W. Krejci. (6) Oct. 20, 1917.
Zinc Oxide Furnaces. J. F. Cregan. (6) Oct. 20, 1917.
Copper Metallurgy of the Next Generation : a Forecast. E. P. Mathewson. (6) Oct. 20, 1917.
Metallurgy of Antimony. K. C. Li. (6) Oct. 20, 1917.
Tennessee Copper Co.'s New Settlers. T. W. Cavers. (6) Oct. 20, 1917.
Electric Smelting of Copper Ores. W. Dewar. (35) June, 1917.
Ore Treatment at the Perseverance Mine. W. R. Cloutman. (35) Serial commenced May, 1917.
Estimation of Tungsten in Presence of Phosphorus. W. Dewar. (35) May, 1917.
The Constitution of Pyrites and Allied Minerals. W. H. Goodchild. (35) May, 1917.
On the Superheating of Slags and Metals During Refining, Smelting, and Alloying Operations. J. E. Fletcher. (3) Oct. 1, 1917.
Sulphuric Acid from Blende. H. M. Ridge. (3) Sept. 1, 1917.
Mining and Smelting Copper Ore at Kalata. F. W. Draper. (8) Sept. 1, 1917.
Flotation Physics. B. Stevens. (8) Sept. 8, 1917.
Soluble Frothing Agents. C. L. Perkins. (8) Sept. 8, 1917.
Scale-Shellshear Flotation Apparatus. (8) Sept. 8, 1917.
Precipitating Gold from Coppery-Cyanide Solutions. R. Lindsay. (8) Sept. 8, 1917.
Solubility and Orientation of Molecules in Surface of Liquids. (8) Sept. 8, 1917.
Cyanidation of Flotation Concentrates. J. G. Parmelee. (8) Sept. 15, 1917.
Simple Method of Finding Density and Weight of Solids in Mill-Pulp. R. B. Kiliani. (8) Sept. 15, 1917.
Mill-Tests *v.* Hand-Sampling. M. Webber. (8) Sept. 29, 1917.
The Synthetic Making of Sodium Cyanide. G. H. Clevenger. (8) Oct. 13, 1917.
Chemicals Used in Flotation. O. C. Ralston and L. D. Yunat. (8) Oct. 13, 1917.
Flotation of Lead and Zinc in the Joplin District. C. A. Wright. (8) Oct. 20, 1917.
Preferential Flotation. W. Shellshear. (8) Sept. 27, 1917.
Zinc Furnace Temperatures. E. M. Johnson. (3) Serial commenced Sept. 15, 1917.
Oxide of Zinc. G. C. Stone. (29) Bull. No. 129.
The Milling Practice of the St. Joseph Lead Co. L. A. Delano. (29) Bull. No. 129.
Some Economic Factors in the Production of Electrolytic Zinc. R. G. Hall. (29) Bull. No. 129.
Zinc Dust as a Precipitant in the Cyanide Process. W. J. Sharwood. (29) Bull. No. 129.
A Uniform Sizing Diagram from Different Screen Standards. J. Randall. (29) Bull. No. 129.
Concentration Practice in South-East Missouri. A. P. Watt. (29) Bull. No. 130.
Ore-Dressing Practice in the Joplin District. C. A. Wright. (29) Bull. No. 130.
Palmerston Zinc Refractories. C. P. Fiske. (29) Bull. No. 130.

MINING.

Timber Sets for Large Tunnels in Swelling Ground. (6) Oct. 6, 1917.
Block-Stoping and Timbering in Deep Placer-Mining. E. E. Fleming. (8) Sept. 15, 1917.
Miami : the Mining of the Ore. T. A. Rickard. (8) Sept. 22, 1917.
Skip-Changing Devices at Butte Mines. T. Pilger. (8) Oct. 27, 1917.

Mining Methods at the American Zinc. Co. of Tennessee. H. A. Coy and H. B. Henegar. (29) Bull. No. 129.
Development and Underground Mining Practice in the Joplin District. H. I. Young. (29) Bull. No. 129.
Steam Shovel Mining of Bituminous Coal. H. H. Stock. (29) Bull. No. 129.
Zinc Mining at Franklin, N.J. C. M. Haight and E. M. and B. F. Tillson. (29) Bull. No. 130
Resistance of Artificial Mine-Roof Supports. W. Griffith. (29) Bull. No. 130.
A Fresh Aspect of Intensive Mining Thin Seams. G. Gibb. (26) Oct., 1917.
Acetylene Mine Lamps. W. Maurice. (26) Aug., 1917.

MISCELLANEOUS.

Necessity of Mechanical Ventilation for Metal Mines. (6) Sept. 29, 1917.
Cost Reduction on the Rand. (6) Sept. 29, 1917.
Underground Mine Sanitation. (6) Oct. 6, 1917.
Graphite. L. W. Brooks. (8) Sept. 15, 1917.
Method of Filing Drawings. A. G. Wolf. (8) Sept. 22, 1917.
The Zinc Ores of the Joplin District: their Composition, Character, and Variation. G. Waring. (29) Bull. No. 129.
The Effects of Cross Faults on the Richness of Ore. E. K. Soper. (29) Bull. No. 130.
A Logarithmic Calculator. D. R. Robinson. (28) Sept., 1917.

Papers and Discussions.

CONTENTS.

PAPER—
Notes on the Phillips River Gold and Copper Field (with 2 Plates and 4 Figs.). By M. R. M'Keown - - - - - - - 1

NOTES ON THE PHILLIPS RIVER GOLD AND COPPER FIELD.

BY M. R. M'KEOWN.

THE Phillips River gold and copper field is situated on the south coast of Western Australia, about 200 miles east of Albany, 180 miles west of Esperance, and 250 miles south of Southern Cross, forming the southern extremity of what Mr. H. P. Woodward classes as the fourth belt of Pre-Cambrian rocks, and the first auriferous belt, which extends northward through Southern Cross, Mount Magnet, and Cue. The field may be considered the premier copper producer of the State.

The first mineral discoveries were made about 1892, when gold, copper, and iron pyrites were found; but, owing to the isolation of the district and the scarcity of water, both in the locality and on the route thereto, little work was done for some years. In 1899, however, payable gold reefs were opened up, and the district began to attract attention.

PHYSIOGRAPHY.

The southern portion of the district is composed of limestone and sandstone rocks, forming the coastal series, and is for the most part flat, broken only by a few low hills and ridges, except to the west, where Cape Barren and Eyre's Range stand out

[This paper is separately bound, and may be if so desired, detached complete from this number.]

prominently. Vegetation consists of stunted scrub and extensive tea-tree swamps. It is from this locality that the limestone flux is obtained for the smelters.

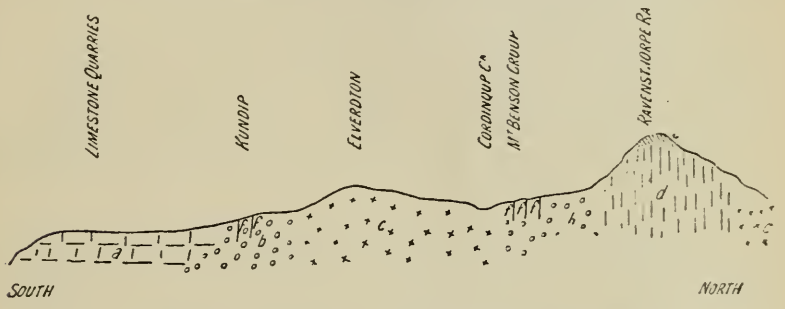
On approaching Kundip, 20 miles inland, the southern extremity of the Ravensthorpe Range is encountered, and the country rises rapidly into an elevated table-land, consisting of undulating to rough country, bounded on the east and north by the Ravensthorpe Range, a very striking formation, and extending westward in a series of hills and ridges. This area, in which is situated the Ravensthorpe group of mines, is composed of practically barren granite country, rich alluvial flats, and areas of deep and good soil overlying the greenstone formations, which latter are covered with dense mallee, developing to the west into timber of greater value for firewood and mining purposes; while on the alluvial flats and along the gullies and creeks timber of considerable size and value occurs. Thus the granite and greenstone formations are clearly defined, and greenstone dykes traversing the granite are readily traceable by the difference in type and luxuriance of the vegetation.

Geology.

The geology of the district is of a very complicated nature, and would require a close and extended study; therefore the following brief description does not pretend to be more than the result of notes and observations made during such time as was available for a limited geological examination.

The oldest rocks are those extending north from Kundip, and comprise schists, quartzites, granite, and some of the greenstone. No fossils have ever been discovered in any of the formations likely to contain organic remains, therefore no geological age has been given these rocks, though classed by Mr. Woodward as Pre-Cambrian. It is possible that the coastal series may contain fossils, but, as these are apparently the latest formation, no light would be thrown on the age of the older rocks, for there is reason to believe that the sandstones of this series covered portions of the present table-land.

What seems to be the most ancient series of rocks comprises those forming the Ravensthorpe Range, and consists of highly altered schists and quartzites, which are probably metamorphosed sedimentaries, with a foliation parallel to the direction of the range. This series is cut through by the Cordingup Creek on what is evidently an extensive fault, which has caused a considerable alteration in the direction of the range, the northern portion being swung round about 15° toward the west. The creek follows



a. Sandstones & Limestones c. Granite e. Ironstone b. Greenstone d. Metamorphic f. Lodes

FIG. 1.

SKETCH, GEOLOGICAL SECTION (30 MILES) NORTH AND SOUTH THROUGH KUNDIP AND BENSON GROUP.

this fault along a gorge for about two miles, but, owing to the extreme weathering, no unaltered rock can be found along the sides.

Throughout the length of the range ferruginous bodies occur interbedded with the schists and quartzites, which, in many places, are capped by extensive masses of ironstone, having the appearance of gossan outcrops. At a point almost north from the Maori Queen mine a party of prospectors put down a shaft from the crest of the range to a depth of 130 ft., supposing the ironstone represented the outcrop of a copper lode. Nothing but weathered and altered rock, with almost vertical foliation, was passed through to the bottom of the shaft, while the narrow,

ferruginous, lode-like formation rapidly pinched out, though stains of iron oxide persisted.

In another instance, on a small ridge of these metamorphic rocks, for the most part ferruginous quartzite, a pot-hole exposed an appreciable amount of arsenical pyrites.

These ironstone bodies are quarried for flux for the smelters, and have so far extended to no depth. At the Phillips River Gold and Copper Co.'s Iron Knob quarry a shaft was sunk to 70 ft., passing through altered rock with veins of iron oxide. Some hopes were entertained that these deposits might be outcrops of copper lodes, some copper stains having been observed, but diamond-drilling operations by the above company failed to discover anything of value. In one instance, however, a lode of iron pyrites was penetrated at a depth, but it did not contain copper.

Near Mount Desmond, some distance further south, a tunnel has been driven under a large manganese outcrop, and some distance below it, to ascertain if it continued to any depth, but passed through nothing but altered rock with small stringers of iron oxide. Thus it seems evident that these ironstone deposits are not lode outcrops, nor gossans in the true sense of the term, but merely cappings, being probably similar to the Corona "lodes" at Broken Hill, N.S.W.

The metamorphic rocks are intruded by granite, which covers an extensive area south of the range, outcropping in an unaltered state. The granite has been in turn intruded by a large mass of greenstone * to the north-west of the town of Ravensthorpe, and from which an extensive system of greenstone dykes extends through the granite in a south-easterly direction.

These dykes are themselves intersected by others of pegmatite and felsite, and it also seems there is a second and later series of greenstone dykes far less extensive, these also being intersected

* The greenstones comprise several varieties. The older massive greenstone has not been classified. The later greenstones are classed as camptonite and kersantite, while those of still more recent origin include diorite, diabase, and amphibolite.

by pegmatite. It is the later dyke-systems in which the copper deposits occur, and these dykes intersect both the granite and the older greenstone.

The youngest formation is that extending from Kundip to the sea, and consists of sandstones, conglomerates, quartzite, and limestone, and at one time covered the granite and greenstone in which the Kundip ore-bodies occur.

The mines of the Ravensthorpe group may be divided into those working (1) auriferous quartz reefs and (2) copper lodes.

The auriferous lodes are confined to the greenstone area lying north-west of the town, and occur along lines of fracture where movements of the rock-mass have produced varying quantities of crushed material along the plane of movement. The quartz appears in some cases to be of metasomatic origin, replacing the mineral constituents of the crushed rock, and has often penetrated for short distances into the more solid country. The walls are often well defined, and the quartz occurs in shoots separated by barren country, through which, however, the fracture-plane continues, the siliceous solutions having followed the more easily permeable sheared sections. Horses and intrusions are encountered.

In other cases the quartz is of a more massive character, and has probably resulted from direct deposition in fissures in the greenstone. Instances also occur in the granite area, one typical gash-vein on the smelter hill assaying 3 dwt. gold. This type of deposit does not promise to be as persistent at depth as that previously mentioned, and it is probable that cases in which auriferous quartz-lodes have passed into comparatively unaltered greenstone at a shallow depth could be traced to this class.

The workings are usually of a very superficial character, seldom exceeding 100 ft., so there is little evidence on which to base any opinion as to permanency. In two instances where more extensive work has been accomplished—viz., the Floater gold mine, where the deepest workings are about 300 ft., and the Maori Queen mine, about 200 ft.—the writer was informed that the reefs maintained the characteristics visible in the shallower

workings, but the gold contents were considerably lower. The oxidized zone seldom extends below 50 ft., when iron sulphide and occasionally a little copper occur, while the gold content of the oxidized zone is not greatly richer than that lying below, values declining very steadily. No sensational yields have ever been obtained, the maximum value of the best finds seldom exceeding 3 oz., while the general run of the best stone is from 1 oz. to 30 dwt., decreasing as the sulphide zone is penetrated. In one mine examined and sampled by the writer the difference in values between the oxidized and sulphide zones—the vertical distance between levels being 60 ft.—was less than 2 dwt. No copper ore was showing in the bottom level.

The auriferous deposits are frequently intersected by dykes which have had no influence upon the mineral contents, and in neither the gold nor the copper mines (with one exception, to be referred to later) have intrusions influenced or been responsible for the deposition or enrichment of the lode minerals.

With regard to the permanency of the auriferous lodes, Mr. A. Montgomery, State Mining Engineer, who has had extensive opportunity for examination, considers that the quartz in the lodes of metasomatic type is essentially of deep-seated origin, and that values should persist in depth.

The copper lodes occur in greenstone dykes at or near their contact with granite. In the Mount Cattlin group of mines the lodes are found in hornblendic dykes penetrating the evidently older greenstone, and at some considerable distance from the granite contact. The outcrops are frequently gossan, containing a large amount of quartz, passing into very schistose dyke-rock, which merges into solid greenstone at water-level. This siliceous gossan carries fair gold values. The zone of oxidation in the copper lodes presents somewhat different characteristics, according to whether the lode is in greenstone or granite country. In the former the leached portion of the zone is not of great depth, blue and green carbonates and grey copper ore being met at shallow levels. There is no zone of secondary sulphide enrichment, for, with the exception of a little covellite, the oxidized ores pass

directly into sulphides, consisting of chalcopyrite, pyrite, pyrrhotite, and marcasite at depths varying from 20 to 50 ft., while water-level is not met till 60 or 80 ft. have been sunk.

Marcasite and pyrrhotite are more characteristic of those mines where the country-rock is greenstone than granite. In the Mount Cattlin mine some secondary concentration has taken place in the case of marcasite, which, in one or two places, occurs in a very massive form and assays under 1 % Cu.

When the copper-bearing dykes traverse granite the zone of oxidation and leaching often extends to a depth of 50 ft., being totally devoid of copper, only stains being present. Gold has remained behind during the migration of the copper, and these portions of the lode are often worked, particularly at Kundip, as gold mines. In the oxidized portion of the zone of deposition quantities of ferruginous earthy carbonate ore are found, but with no extension in depth. Secondary sulphide deposition is again absent, with the exception of a little covellite, and primary sulphides follow immediately.

The carbonate ores do not show any great degree of concentration, and their richness varies with that of the underlying sulphide.

The primary sulphides are evenly distributed and disseminated throughout, the ore-shoots, the chalcopyrite, pyrite, pyrrhotite, and other associated minerals being always in close contact. In the two deepest mines on the field there is no decrease in copper values nor change in the manner of distribution of the particles from the top of the sulphide zone—about 80 ft. down—to the lowest level, 500 ft. The gold values in the copper lodes are very constant, and rarely show any decrease with depth.

The ore in the copper lodes is the result of metasomatic replacement of the dyke constituents, a considerable amount of silica being deposited with the sulphides. The dykes are traversed by numerous fault-planes or lines of dislocation, due to differential movements in the dyke, in a similar manner to several of the quartz lodes in the greenstone belt, and these planes have

evidently served as passages for the ascending mineralized solutions. The earth-movements associated with the formation of the fault-planes have probably been connected with a later series of intrusions. The planes show much evidence of continuity in the direction of the strike of the dykes, and, though signs of movement are sometimes seen, it seems to have been slight, and to have occurred prior to the deposition of the ore-minerals. No effort has been made to trace the position of the planes from level to level with a view of establishing their vertical continuity, but it seems very likely that if this were done a definite system would be proved to exist. Though much evidence has been destroyed in stoping, there is reason to believe that they have been more numerous on the western side of the dyke, where the largest ore-bodies have been found. C. O. G. Larcombe * refers to such occurrences as planes of parting, and remarks on their wall-like appearance and trouble occasioned thereby in driving, but with regard to Kalgoorlie, while ascribing an origin later than the period of auriferous deposition, credits them with affording a passage for a different series of minerals.

The Kundip group of mines occurs in greenstone, at some distance from the granite. The lode-material is ferruginous quartz carrying fair to good gold values, probably due to differential enrichment through the migration of the copper. These lodes are worked as gold mines, recovery being effected by amalgamation and cyanidation; but at water-level the increasing copper-content interferes with cyaniding, and it seems certain that these deposits will develop into copper lodes as greater depth is reached. In one instance, however, the lode occurs in granite, and, though the workings have attained some depth, it is claimed that no copper has been found.

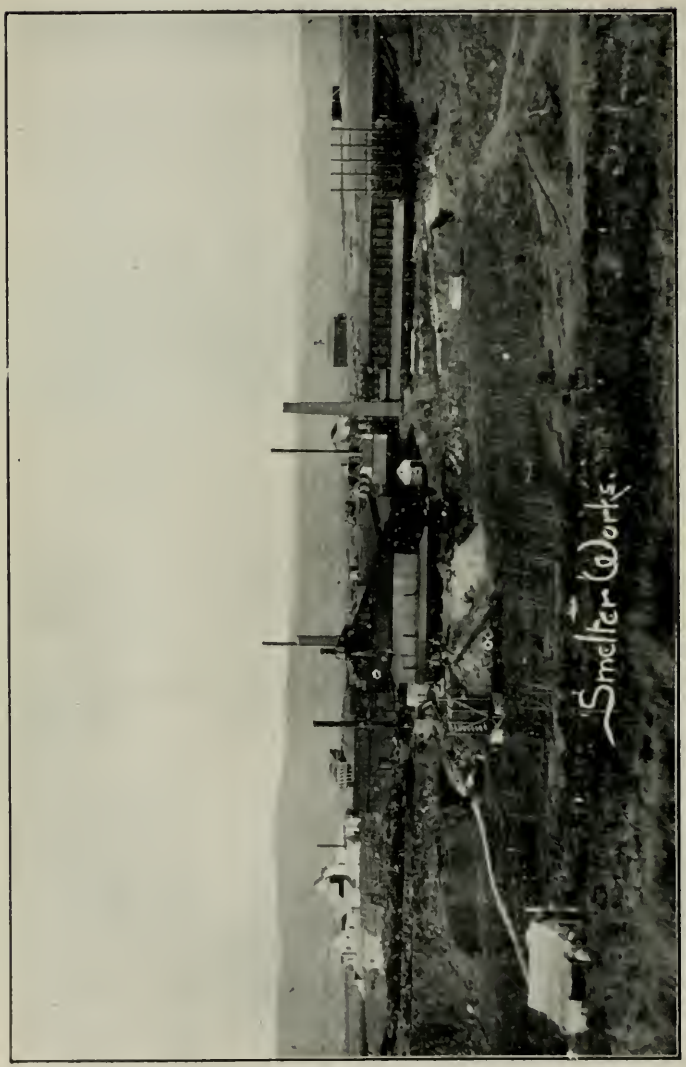
In the auriferous belt north-west of Ravensthorpe, the State Mining Engineer, Mr. A. Montgomery,† noticed one instance of copper occurring in appreciable quantity in a quartz lode at its point of contact with an intersecting greenstone dyke. He ad-

* "Trans. Aust. Inst. M.E.," vol. xiv., p. 108.

† Progress Report, Phillips River Gold and Copper Field.

Mt. Cattlin Mine, Ravensthorpe, W.A.

Elverdton Mine, Ravensthorpe, W.A.



Smelter Works, Ravensthorpe, W.A.

vances the suggestion that the auriferous lodes, almost free from copper, were formed at an earlier period to the cupriferous dykes. This is, unfortunately, the only occurrence noted so far, but the idea is one of considerable interest, and seems very probable. An examination and study of the various greenstone dykes in the district would be instructive, for it has been shown by the Western Australian Geological Survey that those dykes in which the larger deposits are situated are composed of a distinct variety of greenstone, and further investigation might throw light on the relative ages of the two classes of lodes. The cupriferous dykes, as well as the quartz lodes, are frequently intersected by later intrusions of pegmatite and diorite, and some faulting has occurred.

With regard to the permanency of the copper lodes, in the majority of instances the work is of too limited a character to disclose much evidence. A number of the ore-bodies are small, narrow, and of low grade, but others are large and of promising appearance. Owing to the heavy flow of water below water-level, and the increasing hardness of the country, operations are stopped through lack of capital and machinery, but some of the small mines appear decidedly good.

Two mines, however, have reached a depth of 500 ft., and the evidence afforded by these points to the probability that both they and some of the more important of the small mines have very good prospects of extension in depth and continuity of values. The dyke-formation in which the ore occurs, the numerous and persistent fracture-planes, point to deep-seated origin, while, as shown so far in the two largest mines, metal values persist unaltered to the bottom levels and the ore-bodies maintain their size.

The Phillips River Gold and Copper Co.'s Mines.

The above company is the largest on the field, owning the Mount Cattlin, Marion Martin, Mount Benson, Mount Desmond, and Elverdton mines, the two former being situated in the greenstone area, the lodes being intrusive greenstone dykes. The Marion Martin contains shoots of rich sulphides, but of small size.

The Mount Cattlin mine has been developed to 500 ft., levels being driven at 100, 200, 300, 400, and 500 ft., disclosing two shoots of ore about 120 ft. long and from 4 to 20 ft. wide. These two shoots are separated by a dyke of later age, but no dislocation to the lode has resulted. The lode consists of a basic dyke containing chalcopyrite, marcasite, and pyrrhotite, quartz, and considerable quantities of hornblende, the specific gravity of which closely approaches that of the sulphides. The oxidized zone extended downward only 52 ft., being immediately followed by primary sulphides. In one portion of the mine the wall-rock contains garnets, and the writer was informed that the presence of garnets is considered a good indication for copper.* The ore in bulk averages 5.7 % Cu, and is far less siliceous and higher in iron and sulphur than the Elverdton and Desmond ores, but, owing to the higher specific gravity of the gangue, it is a rather more difficult concentrating proposition. This mine is higher in gold than the rest of the company's properties, the average content being about 5 dwt.; but this slightly decreases in the bottom level, though the copper remains of the usual grade.

Although there are good prospects of further shoots of ore being located to the east, practically no exploratory work has been done beyond one drive extending some 200 ft. beyond the more eastern of the two shoots. The mine makes 110,000 gal. water per diem, and great trouble was experienced owing to its action on the iron pipes. These were eventually replaced by a wood-pipe column, with excellent results. In sinking the shaft to 400 ft. a heavy flow of water was struck, and this increased so rapidly that the lower workings were flooded, and further sinking was impossible for some time. When the workings were eventually drained it was found that the water-level in the Mount Benson mine, two miles away to the east, had fallen, and subsequently remained, about 90 ft. below the old level. This may

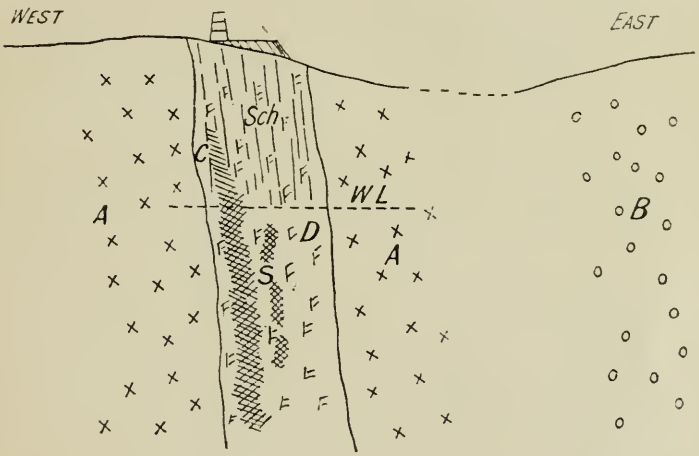
* In view of the intimate association of garnet with the Broken Hill ores, this fact was interesting, but investigation showed that the garnets seemed confined to the upper and more schistose portions of the greenstone, were not generally associated with the ore, and were not found to any extent in the denser country below water-level.

indicate the continuity and extent of some of the previously-mentioned dyke-movements.

The mine equipment consists of a geared winding engine, air compressor, rock breaker, and picking belt, delivering the ore into bins over the railway siding.

The Mount Benson mine is situated on a granite and greenstone contact, but, though the shaft was down 200 ft., and a large amount of driving and crosscutting carried out, exposing ore of high grade, the mine was idle.

The Elverdton mine is the largest producer on the field. The lode is an intrusive greenstone dyke of the variety classed as



A. Granite Sch. Schistose dyke rock C. Carbonate Ore D. Greenstone Dyke
WL. Water Level S. Sulphide Ore B. Greenstone

FIG. 2.
SECTION OF DYKE AT ELVERDTON MINE.

kersantite by the Western Australian Geological Survey.* the country-rock being granite. The constituents of the lode are

* Kersantite is described ("Geological Survey Bulletin 35") as "a fine-grained, dark-coloured dyke rock, composed of a granular mixture of clear felspar and biotite, with a little hornblende and quartz. The silica percentage of a typical sample was found to be 59, and the sp. gr. 2.81."

chalcopyrite, pyrite, quartz, and a little magnetite, the dyke being much altered and very schistose above water-level. Some galena is present in places in small aggregates of distinct, well-formed cubes.* The ore-shoots, three in number, are discontinuous, and appear to be arranged across the dyke in a diagonal manner, being from 60 to 180 ft. in length and from 6 to 10 ft. wide.

Near the main shaft a large fault has heaved the lode about 90 ft. to the south-east, and on the south side of the fault, as far as exploratory work has shown, the ore-body is narrow, but shows signs of improving both in size and grade.

Great difficulty is experienced in following the ore-bodies, owing to the fissure-planes, which have the appearance of walls, and drives have frequently departed from the right course, the result being much unnecessary work and often the idea that the shoot had pinched out. Stoping has, however, subsequently proved the continuation of the ore through the supposed blank areas, the ore lying behind the planes, which had been mistaken for the wall. The original belief was that the ore-bodies lay upon the western side of the dyke, close to the granite, but exploratory work by crosscut and diamond drill proved the existence of ore further eastward in the centre of the dyke. It seems that both here and in the Cattlin mine a system of crosscuts or drill-holes is necessary for successful working on account of the ease with which ore-bodies can be passed by. The mine is opened up by levels at 129, 249, 350, and 500 ft., the total length of the workings being about 600 ft. The shoots maintain their length and width with increasing depth, and both gold and copper values are constant, being about 6 % Cu and rather under 3 dwt. Au. Some portions of the mine yield copper assaying 12–13 %, and one or two gold assays from the bottom level have been higher than from the levels above.

* A prospector reported having found what he described as a lode of galena, 2 ft. wide, about two miles east of the Elverdton mine. This would probably be situated in the belt of ancient metamorphic rocks, but, unfortunately, an opportunity was not available for examination of the discovery.

In this mine the shrinkage system of stoping has been adopted, but the walls are not good, and it was subsequently found that large quantities of the broken ore could not be withdrawn without danger to the mine. Ordinary open-stoping with mullock kept well up to the back would prove the better method. The levels are stull-timbered. The mine makes 90,000 gal. water per diem.* Surface equipment comprises a first motion winding engine, 2 air compressors, 2 B. and W. boilers, Stirling boiler, rock breaker, and conveyer belt, raising the ore to the sorting floor, where it is classed into firsts (or smelting ore), seconds (or concentrating ore), and waste.

In the Mount Cattlin mine shrinkage stoping was introduced and abandoned, it being found that the broken ore lying in the stopes fused, and considerable trouble resulted.

The Mount Desmond mine is situated north of the Elverdton, and on the same dyke. Nothing has been done to prove the continuity of the ore-bodies between the two mines, but the appearance of the material exposed in several shallow shafts indicates that deeper sinking and more extensive prospecting might disclose deposits of value.

The lode, or mineralized portion of the dyke in the Mount Desmond mine is considerably wider than in its neighbour, being from 20 to 60 ft. in width, but of lower grade, and would average about 4–5 % Cu, though several fairly large patches of higher-grade ore occur. The mineral contents are well distributed, and gold values are 2–3 dwt. The shaft is down 250 ft., and levels driven at 96 and 196 ft., the extent of the workings being about 500 ft., while shallow shafts and workings to the north have proved further extensions of ore. This mine, if opened up vigorously, would undoubtedly be the largest mine on the field, though essentially a concentrating proposition. The character of the dyke, the occurrence of the fault or fracture-planes throughout

* Analysis Elverdton mine water:—

NaCl	.. .. ..	880 gr. per gal.
$MgSO_4$	.. .. ..	50 „
Fe	.. .. ..	traces

it, and the nature of the sulphides are similar in all respects to the Elverdton mine, which gives every indication of extension in depth, so there should be no doubt as to the deep-seated origin of the Desmond ore-bodies. This, together with the width of the lode and evidence of horizontal extension, points to the future value of the property.

The Phillips River Gold and Copper Co.'s Works.

The smelter, mill, and offices are situated two miles from the town of Ravensthorpe, and the site is open to question. The chief centre of production, the Elverdton mine, which supplies 75 % of the smelting and milling ore, is 7 miles away, the Mount Cattlin mine 3 miles, thus necessitating a heavy charge for freight from mine to smelter, in addition to the extra railage on coke, limestone, and other supplies from the quarries or the port of Hopetoun, and the expense incurred on carriage of the valueless constituents of the ore. In addition, the grade from the main line to the smelter bins is very severe, loads being limited to 50 tons. The situation of the works is, without doubt, a serious handicap to operations, and had they been situated at the Elverdton or Desmond mines considerable economies would have been effected, not only as to transport and freight, but also by concentration of all operations in one place, and the resulting simplification of administration. Ample water is available for all purposes, the source of supply of boiler water being no further away than from the present works.

SMELTER.

These works are situated on the western side of a high hill, and ore, coke, limestone, and ironstone are delivered from hopper trucks of 8 and 25 ton capacity into the bins. These materials are then run from the bins as required into side-tipping trucks mounted on platform scales, weighed, and tipped on to a conveyer belt, which elevates to and discharges into a storage bin on top of the blast furnace, from whence the charge is distributed

into the furnace by means of a chute with movable gates and a baffle plate hung longitudinally in the throat of the furnace. The charge is thus simply and effectively directed and controlled. The furnace is rectangular and water-jacketed, capable of smelting 100 tons of ore per diem, in addition to flux, coke, etc. The slag and matte run to a large forehearth, from which the slag overflows into pots mounted in pairs on trucks, and drawn by horse to the dump. The matte content of the forehearth is equal to one converter charge—3 to 5 tons, according to the state of the converter—and on tapping the matte runs down a spout direct to the converter.

One converter is in use at a time, four others being in various stages of preparation and readiness, and a travelling overhead crane lifts them to the required stand.

Auriferous quartz and kaolin, in proportion of two parts of the former to three of the latter, are used for lining. They are crushed in a jaw breaker and Chilian mill, and the lining is tamped by hand, pneumatic machines having been considered unsatisfactory. A lining stands from three to five blows, the matte being about 30–32 %, and blister copper is produced in the one operation. The copper is poured into moulds carried on a long truck running on rails, and when cool the bars are sampled by boring one hole in each with a machine drill.

The combined smelting ore from both mines averages about 8–9 % Cu, and slags contain 0.5 % Cu. All converter slags are returned and added to the blast-furnace charge. The output of the smelter is 8 tons blister copper per diem, and up to 10 tons has been attained. The blister copper contains 4 oz. Au and 99 % Cu.

Water for the jackets is obtained from the Mount Cattlin mine,* and gives much trouble by reason of the salts deposited the upper jackets suffering particularly. These have now been

* The analysis of this water is :—

NaCl	.. .. ..	1350 gr. per gal.
$MgSO_4$	.. .. ..	80 „
Fe	.. .. ..	traces

removed and replaced with brickwork, with satisfactory results, and the scale trouble has been greatly lessened by the use of caustic soda.

A sintering plant of five 5-ft. diam. pots is provided to deal with the concentrates, and any fine ore from the mines. The pots are reversible, so discharging is a simple matter, the contents falling on cast-iron cones and breaking into blocks, which are further reduced by spalling. The air blast is produced by a Root's blower. Concentrates usually require from 16 to 24 hours for sintering, the reduction in sulphur being about 8 %, and the resulting product is hard and very suitable for blast-furnace work.

Power for the whole plant is generated by three B. and W. boilers of 1619 sq. ft. heating surface, wood-fired, two being in use at one time. The blast for the furnace is delivered by four Root's blowers at 40 oz. pressure, and a single stage compressor supplies the blast for the converter at 15 lb. pressure.

A sample mill, pattern shop, foundry, and fitting shop—the latter of inadequate size to the demand upon it—complete the equipment. The whole works are lighted electrically.

CONCENTRATING.

The concentrating mill was built on the northern side of the smelter hill, the site possessing a fair fall, of which little advantage had been taken. The mill, as originally designed, was as follows :—Ore was discharged from the railway trucks into the crude ore bin, from which it was raised by an 18-in. conveyer belt to a grizzly and No. 3 Gates breaker situated over the fine-ore bin at the top of the mill. A shaking feeder delivered to long and very heavy shakers, making several products, which flowed to six 3-compartment Hartz jigs, the sizes being 30, 20, 10, 5, $2\frac{1}{2}$, and $1\frac{1}{4}$ mm., each jig making concentrates, middlings, and tailings. All the breaker product which failed to pass through the shakers descended 40 ft. to the bottom of the mill to two sets of 24-in. x 12-in. rolls, which also crushed all jig middlings. Fines and slimes went to two Wilfley tables and a Wilfley slime-

table. Power was provided by a B. and W. boiler of 1619 sq. ft.

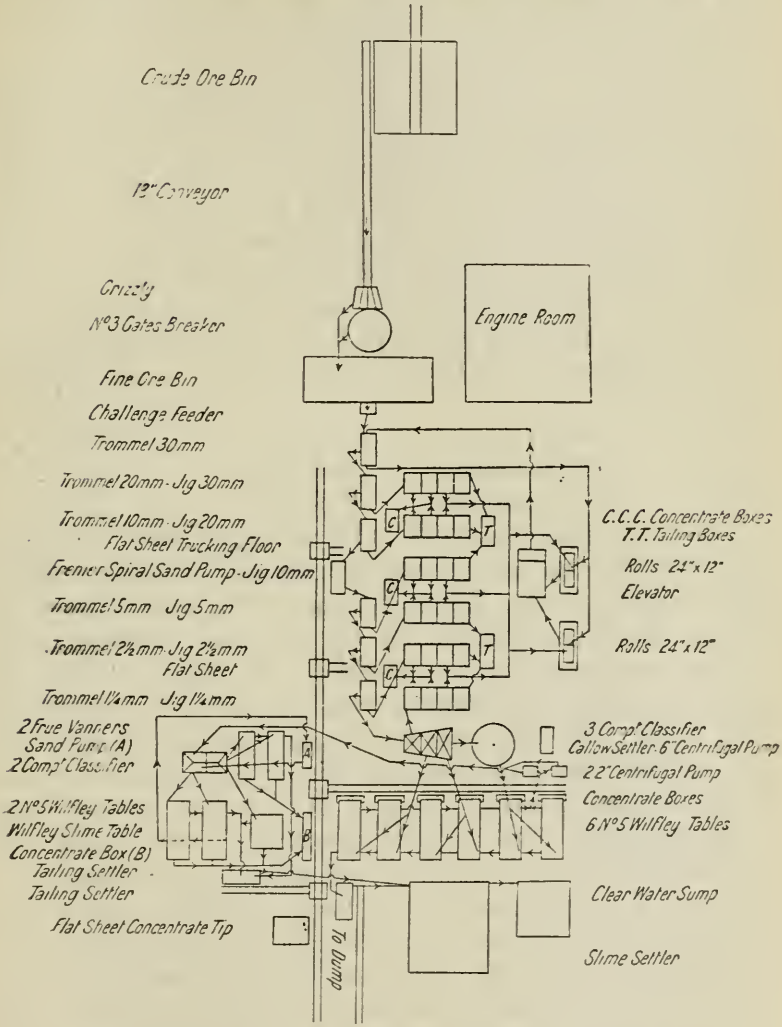


FIG. 3.

CONCENTRATING MILL, PHILLIPS RIVER GOLD AND COPPER CO. LTD.
FLOW SHEET NO. 1.

heating surface, and the mill engine was a horizontal compound of 160 h.p., and running at 120 r.p.m. This plant was intended

to treat 200 tons per diem, but results were so unsatisfactory that it was closed down after little work, and what tailings were produced were subsequently re-treated.

When the writer arrived on the field the mill was in the course of reconstruction. A Challenge feeder was installed, six trommels replaced the shakers, and six No. 5 Wilfley tables and two Frue vanners were added to the fine section of the mill. Water circulation was effected by a 6-in. centrifugal pump driven by the mill engine, and Frenier spiral sand pumps were installed to handle table middlings for re-treatment and also to raise the water and fine product from the first set of three trommels to the second set. Electric light was installed, the dynamo being driven off the main shafting. (See flow-sheet No. 1, fig. 3). The machine speeds were :—

Rolls	.. 30 r.p.m.	Cent. pump	.. 1284 r.p.m.
Jigs	.. 160 pulsations p.m.	Sand pumps	.. 22 „
Tables	.. 240 bumps p.m.	Trommels	.. 26 „

In the reconstructed, as well as in the original mill, the fundamental principle of ore-dressing, that the first crushing must be sufficiently fine to free the greater part of the mineral from the gangue, had been neglected, for the ore was essentially one requiring comparatively fine crushing, and quite unsuited for treatment in the sizings decided upon. In addition, the mill had other faults. The rolls were still situated at the bottom of the mill—in fact, below the trucking floor, the original feed, augmented by raffs, having to descend 40 ft. and be elevated again to the trommels. The jig middlings from 30 mm. to 1¼ mm. were also sent to the same rolls, and without dewatering, for re-grinding. The result was a very large quantity of material in circulation in proportion to the output of finished product, and the efficiency of the rolls under these conditions was very low.

The three-compartment jigs were too small for efficient work or capacity, their tonnage being 1.2 tons per hour, and were capable of only one adjustment—on the disc. The fall from feed end was very rapid, and between hutches was a dead space of 4 in., which kept the feed banked up, while the frames were only

1 in. deep, and made it impossible to retain ragging or build up a bed. Thus a clean concentrate and tail were impossible.

The desirability of fine crushing was soon demonstrated, for on the 30 and 20 mm. jigs a concentrate was as impossible as a rejectable tailing. A concentrate could be produced from the 10 mm. jig, but its bulk was small and insoluble high. In view of these facts, 5 mm. was made the maximum jig size. Improvements were effected in the jigs by deep frames and the reduction of the dead space between hutches, and better work resulted. All jig and table concentrates ran to boxes, were then shovelled into end-tipping trucks, and finally tipped on flat sheets outside the mill, from whence they were carted by drays to the smelter. Jig tails also ran to boxes to be shovelled out and trucked to the dump. Table tails and those from the re-treatment unit were collected in settlers, and, as a result, handled far more cheaply.

The fine product from the last trommel ran to a three-compartment classifier, and its overflow to a Callow settler. The first compartment of the classifier fed the 1¼ mm. jig, the remaining compartments feeding four tables. The Callow settler supplied two tables. The middlings were delivered to the re-treatment unit by two 2-in. centrifugal pumps, which were eventually replaced by a sand pump. The middlings, after classification, were treated on two Wilfley tables, two Frue vanners, and a Wilfley slime-table, the former only making middlings.

Great trouble was experienced through the dynamo and circulating pump being driven by the mill engine, the result being that any stoppage left the mill in darkness, and much water was lost.

After ten weeks' work, during which time costs were between 26s. and 23s. 9d. per ton of ore treated, and the recovery 53 % Cu, it was decided to again close the mill down and carry out the necessary alterations.

The following figures will give an idea of the results during the period :—

Feed, 3.9–4 % Cu.	Cu. %	Insol. %	FeO. %	S. %
Coarse concentrates, 5, 2½, and 1¼ mm.	6.2	49.6	26.5	16.4
Fine concentrates, table and vanner	9.5	40.8	29.7	23.0
Tailings—jig, 1.9–2 % Cu ; table, 1.7 % Cu.				

Reconstruction is seldom satisfactory work viewed from the point of proper arrangement, the existing building influencing the work to be done, and the question was raised as to the advisability of removing the mill to the Elverdton mine, but was eventually negatived. Additional power requirements had to be satisfied by a 70 h.p. engine which happened to be available at the smelter, and it was decided to construct the whole primary crushing section as an independent unit, so that crushing might be carried out on one shift only, which object was difficult of attainment by reason of the irregular delivery of ore from the mines by the railway. No. 2 flow-sheet (fig. 4) will explain the new arrangement.

A No. 5 Gates breaker replaced the No. 3 previously in use. One set of 24-in. x 12-in. rolls was replaced by a set of Austral Otis 30-in. x 15-in. rolls, belt and gear driven, the other small set being erected as an emergency set. Ore was delivered by an 18-in. conveyer belt to the breaker, and by a second belt to the trommels, clothed with 5 mm. screen, from whence the oversize went to the rolls, the undersize uniting with the roll product for elevation to a 5 mm. trommel, from which the raffs were returned and the undersize elevated to the fine-ore bin.

In the original mill-building the Hartz jigs were removed and two compound May jigs installed. Two 8-ft. Forwood Down pans, central feed and classifying discharge, re-ground the jig middlings. As an independent drive could not be arranged for the centrifugal pump, a steam pump was put in.

Under the new arrangement the feed was delivered by the Challenge feeder to a $2\frac{1}{2}$ mm. trommel, oversize to 5 mm. jig, undersize to the $1\frac{1}{4}$-mm. trommel, which delivered its oversize to a corresponding jig, the undersize being elevated to the table classifier. Jig and table tails were run to settlers and trucked to the dump in side-tipping trucks, while the overflow went to the slime-settling tanks.

The concentrates were laundered to an elevator, which also received the table concentrates, and delivered into a concentrate bin, the drained product being carted by drays to the smelter

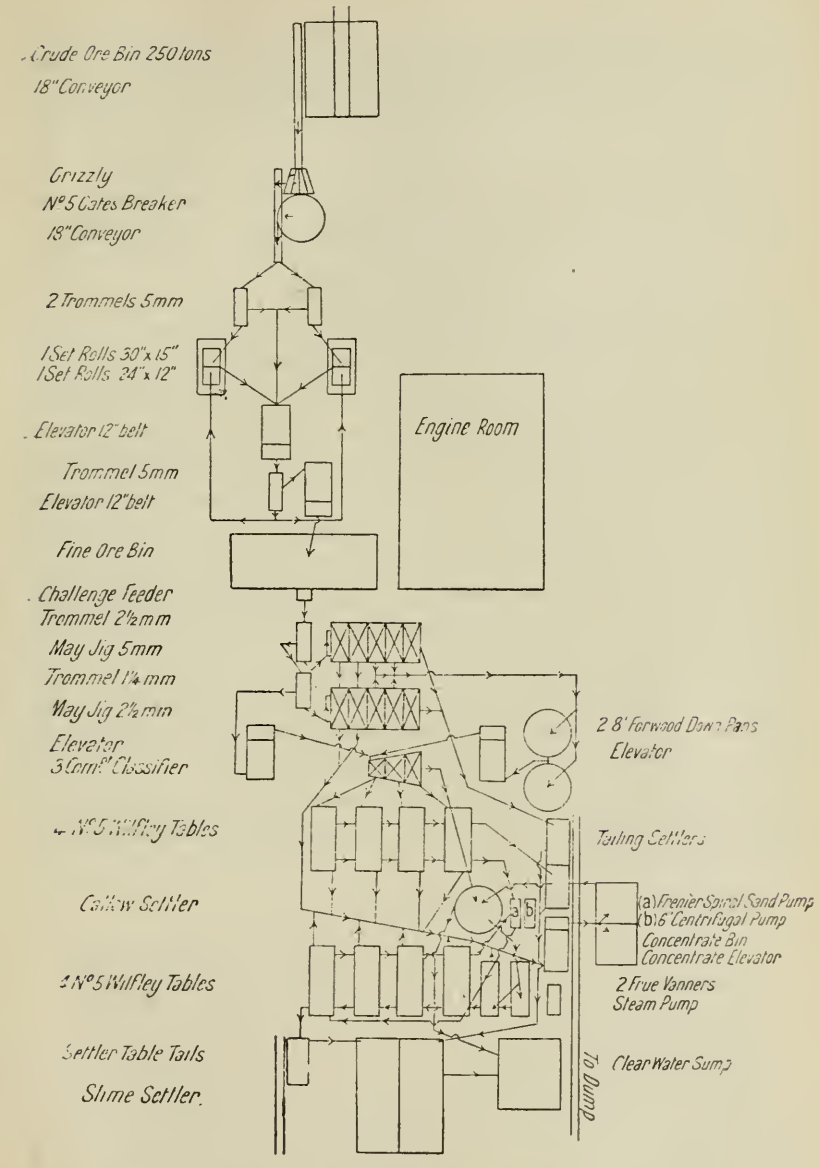


FIG. 4.

CONCENTRATING MILL, PHILLIPS RIVER GOLD AND COPPER CO. LTD.
FLOW SHEET NO. 2.

and the overflow going to a Callow settler feeding two tables, which were later replaced by two Frue vanners, the tables being needed for coarser material. The jig middlings, after re-grinding in the pans, were elevated to the table classifier and distributed to six tables.

As the capacity of the mill was now greatly increased, and additional tables unavailable, a re-arrangement became necessary, too much mineral being lost in the tails. The re-treatment unit was closed down and the vanners placed as mentioned above. Four tables were placed on the jig floor, receiving feed from the three-compartment classifier, which overflowed into the Callow settler. A very heavy concentrate was taken off, and a quartz tailing assaying 0.7 % Cu. The large middling ran to a sand pump, and was raised to the second series of four tables, which treated their own middlings, returned by the same sand pump. The result obtained was a marked improvement, a saving of 0.4 % being effected, the table tails now assaying 1.3 % Cu. On the feed from the Callow settler the Frue vanners did poor work, for, as middlings could not be made, a clean concentrate was not possible without a high tailing.

Further development in the mill was now stopped by—(1) inadequate power, (2) insufficient tables for pan product, (3) absence of tables or vanners for slime treatment.

The results achieved after several months' run are shown by the following figures. The daily tonnage was now 150 tons, being limited for the reasons stated.

Crude ore—3.6–4 % Cu, 0.09 oz. Au.

	Cu. %	Insol. %	FeO. %	S. %	Au. oz.
Concentrates (bulk) ..	11.2	27.3	35.6	20.3	0.25

Jig tails, 0.8 % Cu.

Table tails, 1.3 % Cu.

Slime, 4.1 % Cu.

Recoveries—Cu, 66 %; Au, 57 %.

The improved grade of concentrates now effected a saving of £20 per diem in flux costs. Cost per ton of ore treated, 10s. 2d.

Milling costs included, besides the usual items, railway freight, mine to mill, 1s. 7d. per ton; wood fuel cost 12s. 6d. per ton; and, for the greater part of the above milling period, a drought prevailed, and water for boilers was brought by rail from the coastal swamps at a cost of 10s. per 1000 gal.

		s.	d.	
Rates of wages were :—	Shift bosses	15	0	per shift
	Engine drivers	13	4	„
	Jigmen and oilers	12	6	„
	All other hands	11	0	„

The May jigs proved a complete success on copper ores, and on that from the Elverdton mine—which was a very good one for concentration, specific gravity of gangue being 2.8—a concentrate assaying 14 % Cu and tails carrying 0.5–0.8 % Cu could easily be obtained, while capacity was well over four tons per hour. With the Mount Cattlin ore greater difficulty was experienced, the gangue, composed largely of hornblende, approaching nearer the specific gravity of the sulphides, so that more insoluble was present in the concentrates. As the ore from both mines had to be treated together, the most satisfactory mixture of crudes had to be found by experiment, and was proved to be—Elverdton ore 3, Mount Cattlin ore 1. Owing to the different characteristics of the two ores the concentrates resulting from the combination were lower in Cu and higher in Fe and S, and also in insoluble, than from Elverdton ore alone.

The following figures are for a run of one week on Elverdton ore :—

	Crude. %	Concentrates. %
Cu	3.78 ..	14.6
Insol.	66.5 ..	22.1
Fe	— ..	—
S	— ..	—
Au	0.07 oz. ..	0.215 oz.

A typical analysis of Mount Cattlin milling ore is :—

Insol. ..	43.6 %	Cu	3.23 %
FeO	33.2 %	Au	0.12 oz.
S	—		

The next figures may show the effect of varying proportions of the two ores on the copper and gold assays of the concentrates, the recoveries in each run being practically the same :—

Proportion.			Crude.				Concentrates.	
Elverdton.		Cattlin.	Elverdton.		Cattlin.			
			Cu. %	Au. oz.	Cu. %	Au. oz	Cu. %	Au. oz.
3	:	1	4.65	0.06	4.25	0.115	11.2	0.18
3	:	2	4.15	0.075	3.6	0.14	9.4	0.23
6	:	5	3.88	0.08	4.04	0.185	9.1	0.32

In treating these copper ores several peculiarities were noticeable, particularly in comparison with lead concentration on Broken Hill ores.

The capacity of similar machines was less. On the May jigs, No. 1 hutch produced considerably less concentrate than No. 2, due to the lower specific gravity of the sulphides allowing the particles to be carried further down the jig before settling into the bed than is the case with galena. For this reason it was necessary to limit the speed to 180, otherwise a large amount of free sulphide was carried into No. 3 hutch at the expense of No. 1, while No. 3 could not be built up to produce concentrates without affecting the tails. Experiments proved the desirability of the slower speed, and consequently lower capacity of the jig, and even under these conditions the return of No. 3 hutch to the same machine possessed some advantages.

In re-grinding middlings in the pans, the chalcopyrite had a tendency to split into thin laminæ or flakes up to 1 mm. diam., which either floated across the tables or became so entangled with the gangue particles that the two passed into the tailing launder together.

Though much of the very fine material could be successfully treated on modern vanners such as the Luhrig, or Weir-Meredith in particular—the wider belt of which would possess considerable advantage—the flaking of the chalcopyrite would again be detrimental to good extraction, and, as a consequence, coupled also with lower specific gravity, the slime, untreatable by mechanical concentration, is of a coarser mesh than is typical of lead-zinc slimes.

Experiments were undertaken to test the suitability of the ore for concentration by flotation, and very satisfactory results were obtained in copper extraction, but the gold was not up to expectation. This is due, as was demonstrated to some extent in the company's assay office, to the fact that a proportion of the gold exists in a very fine state in the gangue, and uncombined with any sulphides. This accounted for the lower extraction of gold than copper in the wet mill.

The Elverdton ore is much more easily floated than the Cattlin ore, due to the greater amount of clean chalcopyrite. Recoveries * were (with rain water) :—

Elverdton	.. ..	92 % Cu.
Cattlin	.. .. ..	89 % „

The concentrates obtained from a 3 % crude assayed :—

Elverdton ore .. 17 %–22 % Cu.

Cattlin ore .. figures not available, but grade was considerably lower. This fact was considered to be due to the copper being present in a copper–iron sulphide, and earlier investigations in the wet mill pointed to the same conclusion, apparently clean samples of chalcopyrite always assaying higher in copper from the Elverdton than the Cattlin mine.

The salts contained in the mine waters caused considerable trouble in the first flotation tests, and their influence was counteracted by excess of H_2SO_4 keeping the circuit acid. The recoveries then obtained were as good as with rain water, but the cost of acid at Ravensthorpe rendered the use of mine water prohibitive. The Cattlin mine water, alone, was impossible.

The conservation of rain water for use in a flotation plant was not an insuperable obstacle ; in fact, the Government about that time commenced the construction of a large dam in the vicinity of the Elverdton and Desmond mines, to provide an additional water supply for the town of Ravensthorpe.

The ultimate intention was to erect a flotation unit in connection with the existing mill, but the matter was not proceeded

* From experiments by Mr. J. R. Godfrey.

with, for the company decided that operations were not profitable, and work was suspended on all the properties.

Some months later the State Government, in order to assist the small owners and prospectors, purchased the smelter, which has since then been in operation almost continuously.

Papers and Discussions.

CONTENTS.

PAPER—

Some Notes on the Westonia Goldfield, Western Australia, with Special Reference to the New Method of Controlling Underground Water adopted in the Edna May Deep Levels Gold Mine (with 1 Plate). By N. S. Stuckey - - - - - - - - - 27

SOME NOTES ON THE WESTONIA GOLDFIELD, WESTERN AUSTRALIA,

WITH SPECIAL REFERENCE TO THE NEW METHOD OF CONTROLLING UNDERGROUND WATER ADOPTED IN THE EDNA MAY DEEP LEVELS GOLD MINE.

By N. S. STUCKEY.

THE Westonia gold mining area lies on the western side of the Yilgarn Goldfield and six miles north of Carrabin, a station on the Perth–Kalgoorlie railway.

The principal mines are situated in a narrow belt of gneiss. This belt is about 500 ft. wide at its maximum, and appears to taper at each end, though this is not actually proved. It underlays north at an average angle of about 45°, and strikes nearly east and west.

This gneissic belt is bounded on both sides by greenstone rocks, which appear to lie conformably with the gneiss. Both gneiss and greenstones are intruded with numerous granite dykes derived from the granite masses which form a considerable portion of the adjacent country. In the gneiss, basic dykes of amphibolite also occur.

[This paper is separately bound, and may be if so desired, detached complete from this number.]

The whole of the gneiss carries gold in small quantity, and numerous quartz-veins occur in it, whose strike and underlay usually approximate to that of the whole gneissic belt. These nearly all carry gold in larger quantity than the surrounding gneiss. The principal reefs so far discovered are known as the Edna May reef, the Central "new" reef, and the Consolidated reef.

These reefs are remarkable in that each has more or less the form of a saddle, and are arranged in a series not unlike the Bendigo saddle reefs, except that the saddles follow each other in a horizontal series instead of vertically.

One leg of the saddle in each case turns on to the greenstone footwall rock and the other leg strikes across the gneiss, the strike gradually approaching more nearly to the direction of the planes of foliation of the gneiss as the reef gets further away from the greenstone footwall. The saddle shape is not so pronounced in the case of the Consolidated reef as in the other two.

The minerals associated with the gold on the field are scheelite, wolfram, pyromorphite, wulfenite, stolzite, galena, molybdenite, and iron sulphides. Chromium minerals have also been noted. Wolfram, scheelite, and molybdenite occur in fairly large quantities, the first two sufficient in some places to be of commercial value.

A remarkable feature of the field is the sub-artesian water met with in the Edna May and the Deep Levels mines. The reefs and the country-rock generally are almost impervious to water, which occurs in the oxidized ground in small quantity (derived from seepage from the surface), and in the sulphide ground only in cracks and fissures caused by the intrusion of the granite dykes. The water met with in these fissures is under considerable pressure (sub-artesian), and is probably derived from the rainfall on the granitic rocks which surround the Westonia area. The water would travel down on the junctions of the granite rocks and the greenstones and gneiss, and is carried into the mining area by the cracks made by the granite dykes which traverse the country in every direction. It contains about 3 % salts.

To finally get rid of the water after pumping it to the surface, it would be necessary to carry it clear of the surrounding granite rocks outside the ring of granite that almost certainly exists here. Unfortunately, this has not been done, and the pumping operations being carried on are certainly dealing with a portion of the same water over and over again.

The cost of dealing with this water is very serious, as may be seen by comparing costs in the cases of the Edna May and Central mines.

The Edna May is raising nearly a million gallons daily from 300 ft. deep. The Central is nearly dry to 300 ft., having never intersected any of the water-bearing fissures.

Working costs in the Edna May are stated at 26s. per ton over 3000 tons per month. Working costs in the Central are stated at 14s. per ton over approximately 3000 tons per month. In addition, the Edna May has spent probably £20.000 in pumping equipment and its installation.

In the Deep Levels mine adjoining the Edna May (the main shafts of the two properties are 300 ft. apart), and working the same reef, the sub-artesian water was met with at 250 ft. from surface in the main shaft. About the same time the Edna May had struck the sub-artesian water in a crosscut at 300 ft. deep. At this depth the pressure of water was 80 lb. per sq. in.

It is to be noted that the Edna May main shaft is sunk chiefly in the greenstone footwall rock, and the water-bearing fissures have not been met with in this formation. Hence the Edna May main shaft is comparatively dry, the flow there never exceeding 12,000 gal. per hour.

This made it possible to deal with the water struck in the crosscuts with stationary electric and steam pumps installed at the various plats. These pumps would be useless to deal with water in sinking a shaft. Steam or electric or Cornish sinking pumps would be necessary, and could only have been installed by enlarging the shaft throughout at great cost.

The conditions in the Deep Levels main shaft were different. The shaft was sunk in the gneiss, and had to pass through the

shattered ground carrying the largest volume of water. Had it been possible to instal sinking pumps of sufficient capacity without enlarging the shaft through its whole depth, it would still have been necessary each time a crack was passed through to have cut a plat and a cistern and put in a plunger set of pumps to avoid having the water falling in the shaft. It would be quite impossible to sink with such a flow of water falling. With any system of pumps the work would have been very costly indeed. It was known from the work in the Edna May mine that the shaft had to pass through cracks that would yield 30,000 to 40,000 gal. per hour, and perhaps more.

A Cornish pump 9 in. dia. by 6 ft. stroke had already been installed in the Deep Levels shaft, and that company was not prepared to find the large sum of money that would have been required to instal pumping machinery of sufficient capacity.

Under these circumstances it was resolved to attempt to block the cracks with cement before sinking through them. Great public interest had been taken in the operations at the mine, and it was necessary to announce what means were to be taken to deal with the water. The proposal to use cement was received with great derision, and four Australian newspapers, having a considerable circulation, violently attacked the management, declaring the proposal absurd and ridiculous, and even fraudulent. It was inferred that the proposal was made merely to bolster the price of shares, and that those making it were fully cognizant that it was foolish and impracticable.

Careful preliminary experiments were made, and as a result patent rights were applied for covering the process proposed to be used.

The pump used was made by lengthening the 2-in. tail rod of the Cornish pumping engine and using it as a plunger in a casing made of steam pipe (double), with a gland attached to one end and a four-way piece flanged on to the other end. One branch pipe with two retaining valves was led to the cement-mixture storage tank. Another branch communicated with a lever-weighted release valve. The third branch with two retaining

valves was carried down the shaft to within 12 ft. of the face of rock to be cemented. All pipes were 1½ in. dia. best Lloyd's steam pipe. Brass retaining valves by the same makers were used, and given about ¼-in. extra lift. Construction and material used for this pump cost about £10, and the fly-wheel effect of the Cornish pump-gearing made the whole arrangement very steady running. The pressure available was 2000 lb. per sq. in. by estimate. The pressure used probably never exceeded 1500 lb. per sq. in.

The first trials were made at 250 ft. from surface, and the last crack sealed was at 500 ft. from surface. At this depth the gravity head of the cement mixture in the pipes was about 300 lb. per sq. in., and the release valve of pump was set at 500 lb. per sq. in. Friction in the pipes is a very uncertain quantity, and varies from about the friction of water to the amount of the whole pressure employed when the crack is filled and the cement in the pipes becomes thick. Connection between the hole in the ground and the end of the pipes is made by forcing a piece of pipe into the hole and securing it firmly and without leaks with wood and iron wedges. As this has to be done promptly when the hole strikes water, and against a water pressure of up to 100 lb. per sq. in., special preparations are made. An annular tapered wedge of wood is fitted to the piece of pipe and held on firmly with copper wire. A cock is attached to the upper end, and a specially-made piece to fit the chuck of the machine that bored the hole is fitted to the cock. When water is struck the steel is slipped out of the chuck and the prepared pipe is put in and forced into the hole by the feed screw of the machine. It is then firmly wedged. The water flying from the hole makes it difficult to keep a light, and the job is an unpleasant one. An electric light would be a great advantage.

Between the pipe in the ground and the end of pipe from surface a specially strengthened hose is fixed by means of brass unions. This hose has a cock at its upper end and a small release cock. The release cock is necessary, as the pressure remaining in the hose on completing the cementing of a hole makes it dangerous to uncouple.

The cement used is preferably such a cement as that manufactured by Knight Bevan—" Pyramid " brand—but several other makes have been used successfully. In starting off, the cement mixture should be very fluid and should be passed through a fine sieve to take out any rough particles and pieces of paper and board from the barrels. It was found that a mixture thicker than 50 % cement to water by weight could not conveniently be pumped.

In sinking the shaft one hole was bored at least 3 ft. in advance of the holes to be blasted to guard against unexpectedly firing through into a crack.

If water was struck it was bored on until the water flowed freely (a 1½-in. dia. hole was found to throw upwards of 13,000 gal. per hour at the greatest pressure met with in the shaft). It was then cemented and let stand three days. Fresh holes were then bored, and if any water was met these holes were cemented. If no water was met with the face was fired out. Small leakages were easily sealed by boring a hole to the crack outside the line of the shaft and pumping in bran and oats. This sealed the leakages, and afterwards the pipes were washed out and cement forced in to permanently close the crack.

When cementing, as little time as possible was lost. As soon as the connection to the first hole was made (if a series was to be cemented), the cement was mixed continuously and fed to the pump as quickly as the latter could take it. As soon as the release valve lifted this was signalled to the men at the face, and they at once closed the cock on the pipe fixed in the hole. The cock on the hose was also closed, and the release cock on the hose was opened. The hose was disconnected, and re-connected to the next hole to be cemented. The pump at surface was kept running continuously, the release valve on it closing automatically as soon as the pressure in the pipes fell. Pipes and pump were occasionally washed out (at intervals of not more than half an hour), to avoid the danger of cement setting in them. The cement washed out of pipes was taken to the surface and used over again.

In all, the process has been used to seal about ten cracks when water has been met, the largest crack being from $\frac{1}{2}$-in. to $\frac{3}{4}$-in. wide. No large amount of stoping has yet been done on the reef (which was struck, exactly as expected, at 480 ft. from surface), but large openings, from which 8000 tons of ore have been taken, have been made without any trouble with water. At the 566-ft. level the reef has been cut, and no water at all is making from it. It is intended to continue stoping by the same methods. Shrink stopes will be used, and the water sealed back in the walls where necessary.

Up to thirteen barrels of cement have been pumped into one hole. About 3000 to 4000 gal. per hour of water is pumped at present, being from accumulated leakages, as against upwards of 50,000 gal. per hour pumped by the Edna May mine adjoining. The stoppage of the Edna May pumps would not affect the Deep Levels mine in any way, and the Deep Levels mine is in no danger of being flooded from that cause.

The economy of the process is threefold. Firstly, its use dispenses with large capital outlay on pumping plant. In the case of the Deep Levels mine this outlay in purchase, transport, and installation would not have been less than £10,000 to £15,000, taking into account the enlargement of the main shaft that would have been necessary.

Secondly, the continuous operation of such a plant would absorb £400 to £500 monthly, and any breakdown of more than a few hours would flood the mine, giving rise to expensive damage and delay.

Thirdly, the advantage of working in comparative dryness is very great. Men can do twice the work, and do not suffer the same discomfort. Numbers of men cannot or will not take on work at all in wet places. Also, it is difficult to protect shaft-pumps in firing out hard ground. The heaviest wind bores get broken if allowed to remain on the bottom when firing out, and the lifting of heavy pumps above danger is tedious and allows the water to rise, and, until it is again pumped out, the men are idle. The delays due to pumps working badly, the changing of

bucket pieces, clacks, and other curses attached to pumps are too well known to every miner.

It has been estimated that the extra money required to deal with the water in the Deep Levels mine by pumping would amount to at least £20,000 now, and would be constantly increasing. This estimate is fully confirmed by the experience of the Edna May mine. This amount of money would never have been found, the company's effort would have ended in complete failure to penetrate to or test the reef at all, and the mine would have fallen into the hands of the Edna May Company as a derelict. Now high-grade ore has been cut at the 566-ft. level, where the reef is quite dry and has a very permanent appearance, giving great promise of a highly successful future for the mine. Mr. R. Toms, the fitter in charge of the machinery on the mine, made all the appliances used for the work, and Mr. W. Hewitt was in charge of the underground work. When the scheme was first tried neither believed that it would be successful, and both are now convinced that any water could be dealt with, provided it occurred in hard rock.

It would be preferable, where a very high pressure of water was to be passed through, to use a diamond drill and bore through a gland or stuffing-box for a considerable distance ahead and then cement at high pressure.

A handy pump for use in the stopes has been designed and is being made. This will give a high pressure, and the valves (inlet and exhaust) are operated by hand. Two men can carry it.

The claims covered by the patents granted do not include any appliances. Any ordinary mine appliances are used. In addition to the use of Portland cement in the way described, it is claimed to use saturated solutions of calcium chloride and sodium silicate, alternately pumped into the rock fissures. By the use of these solutions the writer believes a large area of ground cracks could be filled with the precipitated calcium silicate, and permanently sealed from the percolation of water, even in fairly soft country. The final pumping would be done at high pressure to consolidate the precipitate.

Flow of water from diamond drill hole at the 240-ft. level. Edna May Deep Levels Gold Mine.

This hole has since been sealed, taking 13 barrels of cement.

A similar effect would be obtained, where the ground water contained sulphates, by pumping in calcium chloride solution alone, giving a precipitate of calcium sulphate in the cracks. By finishing the pumping at a high pressure the cracks would be tightly packed with precipitate, and permanently sealed. Calcium chloride and sodium silicate could be obtained for about £8 to £10 per ton, or could be manufactured on the ground in many instances fairly cheaply. No actual working tests of these theories have been yet made, but the writer has no doubt they would be successful.

So far as the writer's experience of underground water (in hard rock) goes, he has found the water confined mostly to channels and veins, and believes that it could be controlled in very many instances instead of being pumped.

The process might be used to consolidate gravels or sandy drifts which it might be necessary to sink through. A clayey wash or drift might probably be replaced by a sand concrete mixture pumped in around the line of the shaft desired to be sunk. The process would be very suitable for sealing cracks in concrete reservoir walls or leakages from reservoir bottoms. In sinking dry docks and similar work it would also be very useful. For sealing flows of salt water in bore holes which were being sunk in search of fresh water the process would also be suitable.

In the case of a wet mine which for any reason was closed down and abandoned by the lessees, it would pay the State to have the water flows sealed before the mine was allowed to fill with water. Mines that have been large producers are very frequently re-opened as mining methods are improved or as the conditions under which mining is carried out may be altered for the better. If only the accumulated water had to be removed the cost of unwatering such a mine would be greatly reduced, and hence less capital would be required to re-start operations.

On the whole, there appears to be a wide field of usefulness in mining and other operations for the process when once the prejudice against the innovation is overcome.

The photograph (Plate I.) shows the first flow of water met with in a bore-hole at the 240-ft. level at the Deep Levels mine. The last flow was met with at 500 ft. deep. The extra gravity head at that depth should have been 130 lb. per sq. in. Friction and wire-drawing in the rock-cracks, however, greatly reduced the pressure and flow below that expected. The greatest pressure actually met with did not exceed 120 lb. per sq. in.

The question of cost of shaft-sinking by means of the described method may be of interest. No exact figures can be given, but the total cost of operations since the company started, 2½ years ago, has been £41,000.

The average rate of sinking, including all delays and the time occupied in cutting four plats and driving four levels a total length of about 700 ft., has been about 20 ft. per month. The contract price for sinking only ranged from £8 to £12 per ft.

The above total cost includes £10,000 paid for plant and mine buildings, and also includes breaking and treatment costs on 3000 tons of ore.

The plant consists of a 260-h.p. boiler outfit, winding engine, pumping engine and Cornish lift to 500 ft., a ten-head battery and pumps, 10-drill compressed-air plant, workshop, residence, and office.

The cost of completing shaft to 570 ft. has therefore been about £35 per ft. The upper portion to 200 ft. was expensive, for the reason that the ground was very soft and treacherous, entailing great care in sinking and timbering. Hanging sets suspended by six 1¼-in. bolts were used, and lathing was driven ahead. In the bottom portion of the shaft the cost was made greater because close timber, with concrete behind it, was used in all the leaky sections of the shaft.

It is intended to entirely seal back the water at present being pumped as opportunity occurs.

It is expected, when the plant is fully complete and adjusted, that costs will be about 25s. per ton. At present the ore being broken from development work costs about 30s. per ton, as against 25s. per ton over the stoping tonnage at the Edna May mine.

A higher head-gear on the shaft, a rock-breaker, self-dumping skips, grinding outfit, and cyanide plant have to be added to the mine equipment.

Since writing this paper the author's attention has been drawn to a treatise by Francis Donaldson, M.E., published by the M'Graw Hill Book Co., New York, entitled "Practical Shaft-Sinking," which gives a description of a somewhat similar use of cement for shaft-sinking by the Mining Society of Lens, and also in sinking shafts for the New York City aqueduct.

The writer can, however, state that the idea of using cement in this way, and the work and appliances as carried out and used at the Deep Levels mine, were original, as he had never previously heard of such a method.

In the cases mentioned by Mr. Donaldson the cracks carrying the water were opened up giving full vent to the flow, and great difficulty was experienced in sealing them. Great care was taken in the Deep Levels case never to open up a crack except by one hole at a time. On one occasion the bottom of the shaft burst, giving vent to a large flow, but this was stopped by pumping in bran and oats through a bore hole, and afterwards successfully cementing. Before putting in cement the broken bottom was secured by timbers.

PROCEEDINGS

OF THE

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NEW SERIES.

No. 29.

EDITED BY THE SECRETARY.

This Institute is not responsible, as a body, for the facts and opinions advanced in any of its publications.

31st MARCH, 1918.

PUBLISHED QUARTERLY BY THE AUSTRALASIAN INSTITUTE OF MINING ENGINEERS, MELBOURNE.

Australasian Institute of Mining Engineers.

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The Executive Committee consists of all Members of the Council residing, or for the time being, in Melbourne.

Head Office:

57-59 Swanston Street, Melbourne, Victoria.

Institute Matters.

CONTENTS.

MINUTES OF MEETINGS—	Page
Of the Institute	
Annual Meeting—1918	iii
Report of Council—1917	iv
Balance Sheet	x
Of the Council	xiii
Of the Executive Committee	xiii
NOTICES	xv
PUBLICATIONS—Added to Library	xviii
RECENT ARTICLES—On Mining Matters	xx

MINUTES OF MEETINGS.

OF THE INSTITUTE.

ANNUAL MEETING.

MELBOURNE, 21ST JANUARY, 1918.

IN THE INSTITUTE ROOMS, 57-59 SWANSTON STREET, AT 1 P.M.

Mr. H. Herman occupied the chair.

The Secretary read the notice convening the meeting.

Minutes of the First Ordinary Meeting, 1917, were confirmed.

The report of the Council and Balance Sheet for 1917, were read and adopted.

As the nominations to fill the vacancies created by the annual retirement of office-bearers were not in excess of the vacancies the chairman declared the following elected :—

President - -	J. W. SUTHERLAND, W.A.
Vice-President -	D. B. WATERS, N.Z.
Council - -	E. G. BANKS, N.Z.
	W. H. CORBOULD, Q.
	C. F. COURTNEY, N.S.W.
	H. LIPSON HANCOCK, S.A.
	H. HERMAN, Vic.
	J. W. MOULE, N.S.W.
	E. W. SKEATS, Vic.

Messrs. H. H. Schlapp, G. C. Klug and A. S. Kenyon were appointed to represent the Institute at the conference of the various Australian Engineering Associations and Institutes, convened by the President of New South Wales Engineering Association. to consider the proposal to amalgamate or federate the existing Engineering Associations of Australia. The chairman announced that the conference would commence on 12th February.

The meeting then closed.

REPORT OF THE COUNCIL FOR 1917.

TO THE MEMBERS.

THE Council in submitting its report of the Proceedings of the Institute for 1917 has to state that owing to the conditions arising out of the great world war, which has drawn on 117 of our Members, publication has been seriously restricted and membership reduced.

Members now total 582, made up as follows :—Honorary Member, 1; Life Members, 5; Members, 369; Associate Members, 145; Students, 62.

Nineteen (Members and Associate Members) resigned during the year, five died and three were killed in action at the front. Three Members and four Associate Members were admitted to the Institute. The net loss was therefore 20.

The Council regrets to have to record the loss, by death, of five (5) prominent Members—Messrs. Wm. Frank Grace, General Manager of the Waihi Grand Junction Mine, Waihi, N.Z.; Lawrence Grayson (Foundation Member), late of the Union Engineering Co., Adelaide, S.A.; Ed. Janitzky, of Pymble, N.S.W.; R. B. Nicholson, General Manager Ivanhoe Gold Corporation, Boulder, W.A., and H. P. Richards, late of the Minerva Dredging Co., Wandiligong, Victoria. Members who have made the supreme sacrifice for their King and Country are mentioned elsewhere in this Report.

Two meetings of the Institute were held—the Annual Meeting on 26th January and the First Ordinary Meeting on 26th November. The First Ordinary Meeting was held merely to conform with the Rules, it being considered inadvisable to arrange the usual annual visit on account of the very unsettled conditions due to the war. The President, Mr. R. S. Black, was naturally disappointed that, owing to the war and to the fact that the East-West Railway was not completed, as was expected, the meeting in Kalgoorlie could not be arranged.

Professor R. W. Chapman was, during the year, appointed Local Correspondent to the Institute for South Australia.

Fewer papers were forthcoming than was expected, but several interesting contributions have been promised for the ensuing year. Owing to the paucity of papers the balance to the credit of the Institute is now considerable and will admit of a liberal expenditure on publications during the coming year. It is, therefore, earnestly hoped that Members will assist the Council in securing interesting papers for reading and discussion. Contributions, however brief, will be cordially welcomed, and any suggestions regarding subjects for papers or Members with special information on such subjects will be appreciated.

The Council decided during the year to inaugurate an employment exchange on behalf of Members. Mining companies were notified of this decision and requested to keep the Institute advised regarding positions vacant, and Members were requested to forward to the Secretary particulars of qualifications (i.e., training,

positions held, etc.) making special mention of any branch of mining engineering upon which they had specialized. The suggestion was cordially accepted by companies who have promised hearty co-operation. This exchange should prove valuable to mining companies and also greatly increase the value of membership.

Space was reserved in the Proceedings for the publication of information regarding movements of Members. This innovation has undoubtedly further added to the value of the Proceedings. Members were invited to forward to the Secretary any notes of interest regarding their movements.

Provisions was made for the insertion of Members' professional cards in the Proceedings at the rate of 5s. for one (1) insertion or 10s. per year for four (4) insertions. Members have not yet taken advantage of this privilege.

As reported last year the principal base-metal companies created a fund for the purpose of promoting the University education of Mining Engineers and Metallurgists. This fund is now vested in a Board of Trustees. Two Bursaries and two Scholarships are open annually for competition in the University of Melbourne. The Institute is represented on the Selection Committee by Professor E. W. Skeats. Further particulars may be obtained at the Institute Rooms.

During the year the Institute was in communication with the Advisory Council of Science and Industry on several economic subjects regarding which it was suggested investigation might be made and industries established.

The Council accepted the invitation of the British Board of Trade Commissioner to co-operate in any concrete scheme which the British Engineers Association was prepared to make for the training of Australian apprentices in engineering in Great Britain.

The Engineering Association of New South Wales has kindly offered the use of its rooms and library in Sydney to Members of the Australasian Institute of Mining Engineers. This offer was cordially accepted and reciprocal privileges extended to the Association.

The following is a list of those Members known to be "On Active Service" and shows how splendid has been the response to the Empire's call to arms :—

Aarons, J. Boyd
Adcock, Garnet I.
Alexander, Hubert
Anderson, E. S.
Anderson, W. T.
Avery, Wm. P.
Bayly, Colin (Killed in Action)
Banks, C. A.
Barber, C. S.
Bennet, V. C.
Berriman, R. V.
Best, G. H. T. (Military Cross)
Bell, W. G.
Bell, J. Mackintosh
Bloom, Leo
Blunden, L. E.
Bray, F. P.
Brown, H. Wheeler
Bullen, G. L.
Burbidge, Percy
Campbell, A. G.
Casey, R. G. (D.S.O.)
Carless, Noel
Carroll, H. H.
Connor, J. L. (Killed in Action)
Coulter, Leslie J. (D.S.O.) (Killed in Action)
Cowles, Richard
Clayton, C. H. T.
Cleland, W. L.
Davies, H. Warlow-
Dempster, G. C.
Donaldson, R. J.
Dow, J.
Drain, P. J.
Dubois, A. J.
Dunstan, Basil
Eastaugh, F. A.
Foster. Donald
Foxall, J. S.
Fraser, E. H.
Fraser, D. L.
Finlayson, R. J. Stanley
Gartrell, W. H.
Gabriel, G. E. (Military Medal)
Grieve, W. H.
Goode, K. B.
Grut, L. de Jersey
Hargraves, E. L.
Hammel, H. E.
Herbertson, R. C. (Killed in Action)
Hogarth, A. M. (Killed in Action)
Holder, E. M.
Hopper, F. H.
Horsley, Ralf D.
Hunter, Stanley B. (Member of Council)
Hughes, Eric W.
Irvine, C. L.
Jowett, A. C.
Kelly, A. H.
Kelly, M. B. H.
Key, J. F.
Kneebone, C. S.
Lakeland, Wm. J.
Lewis, Keith B.
Marks, D. G.
Mawdsley, W. H.
Marryatt, Cyril S.
MacDonnell, W. H. A.
MacKenzie, D. C.

M'Bryde, Jas. (Killed in Action)
Mickle, Kenneth A. (D.S.O.)
Millett, Bert
Moore, R. Ingram (D.S.O.)
Morris, A. C.
Mulligan, E. N.
Moore, K. Byron
M'Callum, N. S. Kellie
M'Padden, J. C.
Nicholas, F. H. (Military Medal)
Newman, J. Malcolm
Osborne, G. W.
Pearson, H F.
Peat, James (Killed in Action)
Peberdy, J. R.
Pethebridge, H. S.
Plant, G. H. D.
Rabling, Harold
Roberts, W. J.
Rose, W. J. (Military Cross)
Ross, C. N.
Rutherford, A. R.
Rutherford, T. W. L.
Rae, Cecil
Sayer, W. T. (Killed in Action)
Seale, H. V.
Shaw, J. B.
Smith, R. S.
Smith, W. F.
Smith, E.
Southon, R. D.
Sweet, O. G.
Tandy, A. E.
Taylor, A. S.
Townsend, H.
Tucker, V.
Turner, W. A.
Twine, G. J.
Veitch, Neil A.
Wallmann, H. P.
Warde, Harvey S.
Waters, Professor D. B. (Vice-President)
Watts, R. T. (Killed in Action)
Wentworth, D'Arcy
Weigall, H. S.
Williams, O. B.
Wilkins, Lawrence G.
Woodward, O. H. (Military Cross)

Honours for conspicuous service and bravery have been awarded to the following :—Captain Kenneth A. Mickle (awarded D.S.O.), Captain R. Ingram Moore (awarded D.S.O.), Captain W. J. Rose (awarded Military Cross), Lieut. G. H. T. Best (awarded Military Cross) and Lieut. G. Escott Gabriel (awarded Military Medal).

Three (3) Members were "Killed in Action" at the Front—Major Leslie Coulter, D.S.O.; Captain James Peat and A. M. Hogarth. Major Coulter left Australia on 1st March, 1916, as a Captain attached to the Australian Mining Corps. He was decorated with the Distinguised Service Order in 1916. Prior to his enlistment he was Assistant Surveyor to the Mount Lyell Mining and Railway Co. Captain James Peat left Australia with the first convoy and served at Gallipoli. After recovery from a

severe attack of blood poisoning he left with the 44th Battalion and was killed in action in France. Prior to enlisting he was Chief Surveyor on the Ivanhoe Gold Corporation, Boulder, W.A. A. M. Hogarth was an Associate of the Royal School of Mines and was, prior to enlistment, a mining manager at Friezland (now Kuridala), Queensland.

The matter of incorporation of the Institute has been continuously before the Council during the year, but the absence of a Federal Companies Act prevented any definite progress being made. Under present conditions it is possible to incorporate in one State and register as a foreign company in the other States; but this was considered by the Council to be inadvisable. The Federal Attorney-General has been approached and requested to introduce a small Bill to provide for incorporation throughout Australia. It was considered that, pending the introduction of a Federal Companies Act, this suggestion would meet the wishes of the Institute and of other bodies desiring similar registration.

The formation of an Australian Institute of Engineers has on a number of occasions during the past year been considered by several institutes throughout Australia. Although the question has been much discussed no definite proposal was forthcoming until November, when the South Australian Institute of Engineers communicated with kindred bodies throughout Australia suggesting that meetings of the various institutes be held to consider the matter, and, if thought fit, to recommend the holding of an Interstate Conference. Your Council decided that the question be brought before members at the Annual Meeting and agreed to appoint delegates should an Interstate Conference be arranged. In acknowledging receipt of the communication from the South Australian Institute your Council expressed the opinion that a federation of the existing institutes appeared preferable to an amalgamation, as apparently suggested. It is expected that a Conference will be arranged during 1918.

AUSTRALASIAN INSTITUTE OF MINING ENGINEERS.

Balance Sheet, 31st December, 1917.

LIABILITIES.						ASSETS.					
Subscriptions paid in advance			£2	12	6	State Savings Bank at Credit	£350	0	0		
Accumulated Fund—						Commonwealth Savings Bank at Credit	154	11	3		
Balance at 31st Dec., 1916	£950	7	1							£504	11 3
Add Surplus transferred from Revenue A/c ...	361	10	1			Commonwealth of Australia War Loan	600	0	0		
				1311	17 2	Commonwealth of Australia War Savings Certificates, Due December, 1920 (Face Value) ...	15	7	6		
										615	7 6
						Outstanding Subscriptions, 1916	33	1	6		
						,, ,, 1917	117	1	6		
										150	3 0
						Sundry Debtors for Advertisements		...		19	0 0
						Office Furniture, Melbourne and Broken Hill Branch ...	29	12	5		
						Less Depreciation	4	4	6		
										25	7 11
			£1314	9	8					£1314	9 8

Melbourne, 10*th January*, 1918. Audited and found correct. Oxlade & Mackie, Auditors.

Statement of Receipts and Expenditure for the Year ended 31st December, 1917.

RECEIPTS.

To Commonwealth Savings Bank at Credit ...	£43	18	4			
State Savings Bank ...	269	5	9			
Cash on Hand ...	2	2	0			
				£315	6	1
Members' Subs., 1914 ...	2	2	0			
„ „ 1915 ...	16	7	0			
„ „ 1916 ...	86	19	3			
„ „ 1917 ...	636	1	1			
„ „ 1918 ...	2	12	6			
				744	1	10
Advertisements				54	0	0
Sales				7	6	4
Interest				45	12	11
Entrance Fees				10	10	0
				£1176	17	2

EXPENDITURE.

By Postages, Telegrams, &c.	£26	7	1			
Printing & Stationery ...	14	5	6			
Salaries	256	0	0			
Rent	48	0	0			
Sundries	16	9	10			
				£361	2	5
Proceedings				103	11	6
Commission				7	4	6
Donation—Mining Comforts Fund ...				10	0	0
Commonwealth of Australia War Loan				175	0	0
Commonwealth of Australia War Saving Certificates (Face Value) ...				15	7	6
Commonwealth Savings Bank	154	11	3			
State Savings Bank ...	350	0	0			
				504	11	3
				£1176	17	2

Revenue Account for the Year ended 31st December, 1917.

1917.							1917.						
Dec. 31.	To Publications	£103	11	6			Dec. 31.	By Subs., 1914 ...	£	2	2	0	
	Stationery & Printing ...	14	5	6				„ 1917 ...	761	0	1		
	Postages ...	26	7	1								763	2 1
	Salaries ...	256	0	0				Advertisements and Sales ...				61	6 4
	Rent ...	48	0	0				Interest				45	12 11
	Sundries ...	16	9	10				Entrance Fees				10	10 0
	Commission	7	4	6									
	Donation—Mining Comforts Fund	10	0	0									
					£481	18 5							
	Bad Subscriptions, &c., written off...	32	18	4									
	Depreciation (Furniture)	4	4	6									
					37	2 10							
	Surplus for year transferred to Accumulated Fund ...				361	10 1							
					£880	11 1						£880	11 4

Melbourne, 10*th January*, 1918. Audited and found correct. Oxlade & Mackie, *Auditors.*

Of the Council.

March 4th, 1918—1 p.m.

It was resolved that our Executive Committee, consisting of Members of the Council resident, or, for the time being in Melbourne be appointed for 1918.

Of the Executive Committee.

(Summary.)

January 21st, 1918—12.45 p.m.

The Secretary's report was presented and accounts to the amount of £33 were passed for payment.

Applications for admission to the Institute as Members were received from Messrs. John Joice and Essington Lewis and approved.

The following were elected to the Institute :—Members—Messrs. Frank Fancett Espie, John Frederick Hall, Kenzo Ikeda and Arthur Sydney Winter. Associate Members—Messrs. Frederick Joseph Davies, Walter Gilbert Langford and Philip a'Morley Parker.

Messrs. H. H. Schlapp, A. S. Kenyon and G. C. Klug were appointed Delegates to represent the Institute at a Conference, convened by the President of the Engineering Association of New South Wales, for February 12th, to consider the question of the Federation or Amalgamation of Australian Engineering Institutes and Associations.

Draft of Annual Report for 1917 and Balance Sheet were submitted and approved.

March 4th, 1918—1.15 p.m.

The Secretary's report was presented and accounts to the amount of £82, including printing £25, rent £12 and expenses Engineering Conference £11, were passed for payment.

Resolved that Inscribed Stock, in the Sixth Commonwealth War Loan, to the amount of £400 be purchased.

Nomination of Mr. Thomas Andrew Read as a Member was submitted and approved.

Sub-Committees for 1918 were appointed.

A report of the Conference of Engineering Associations, held in Melbourne on 12th and 13th February, was submitted and discussed. It was resolved :—

"That the Council of the Australasian Institute of Mining Engineers is desirous of assisting other engineering associations in every way to become a corporate body in matters Federal, but is opposed to such Institute being composed of individual members, and strongly recommends delegates to endeavour to induce other representatives to agree to a Federal Institute representing the various existing engineering Institutes of Australia.

A special Sub-Committee was appointed to appointed to arrange for the holding of a First Ordinary meeting for 1918.

March 12th, 1918—1 p.m. (Special Meeting).

A letter was submitted from a Member in the Engineer-Officers Training School in Sydney reporting that he and several other Members after being recommended for commissions were about to be shipped away as sappers. It was resolved that the Minister for Defence be requested to grant an interview to Members of the Council on the matter.

NOTICES.

MEMBERSHIP.

Applications for admission to the Institute as Members have been received from Messrs. Essington Lewis, 320 Collins-street, Melbourne, and Thomas Andrew Read, Broken Hill, N.S.W. These names are now submitted to Members for confidential report.

Since the last issue of Proceedings the following have been admitted to the Institute :—

MEMBERS.

Names and Addresses.

Espie, Frank Fancett, c/o Burma Mines Ltd., Bawdwin, Upper Burma.

Hall, John Frederick, New Zealand Chambers, Queen-st., Brisbane, Q.

Ikeda, Kenzo, c/o Fujita and Co., Dojima, Osaka, Japan.

Winter, Arthur Sydney, Mouramba Copper Mines Ltd., Nymagee, N.S.W.

ASSOCIATE MEMBERS.

Davies, Frederick Joseph, St. Helens, Tas.

Langford, Walter Gilbert, Vailala Oilfields, Papua.

Parker, Philip a'Morley, 25 Victoria-st., London, S.W.

ON ACTIVE SERVICE.

H. Warlow Davies, late manager of Y-Water Tin Mining Co., Emmaville, N.S.W., sailed from Sydney in November last as O.C. of the May Reinforcements, Tunnelling Co., with rank of 2nd Lieutenant.

Garnet I. Adcock was, on 11th January, promoted on the field to the rank of Captain.

W. A. Turner is now a Lieutenant and is Recording Officer and Adjutant, 68th Squadron, A.F.C.

Capt. Alex. Dubois was recently in Melbourne on sick leave. He has been wounded four times and is returning to England to a position on the Permanent Staff of the Army.

A. F. Anderson recently returned to Australia after a strenuous time on the West Front. He was discharged as physically unfit for further service and recently received an appointment with the Burma Mines Ltd.

Eugene Smith has returned from the Front wounded, but is making good progress towards recovery.

Captain Stanley Hunter (formerly Member of Council) has cabled to say that he has been invalided home.

MOVEMENTS OF MEMBERS.

J. W. Horsburgh is now assistant general manager of the Mount Morgan Co.

J. C. Coldham is now general manager of the C.S.A. Co., Cobar, N.S.W.

A. S. Lilburne has resigned as manager of the Occidental Mine, Cobar, and is now in Melbourne.

G. A. Denny who has recently been on a visit to Australia returned to South Africa in December last. He is proceeding to England to take charge of a large munitions factory.

Kenneth C. Church has received an appointment on the Broken Hill Proprietary Mine, Broken Hill.

H. R. Edwards, late of the Youanmi G.M. Co., is now with the Riverina South Co., near Menzies, W.A.

Arthur Jarman, late of Waihi Grand Junction Co., has been appointed chemist to Wilson's Portland Cement Co., Warkworth, N.Z.

FIRST ORDINARY MEETING, 1918.

It is probable that the First Ordinary Meeting, 1918, will be held at Newcastle, N.S.W., and that, in connection with the meeting, a visit will be made to the Broken Hill Proprietary Co's. Steel Works. A further announcement will shortly be made.

AMALGAMATION OR FEDERATION OF ENGINEERING ASSOCIATIONS.

The Institute was represented at a conference of delegates from Australian Engineering Associations and Institutes, held in Melbourne on 12th and 13th February. The conference was convened to consider the proposal to federate or amalgamate all Australian Engineering Societies. The following resolutions were adopted :—

1. That this meeting of delegates recommends that the various engineering bodies of the Commonwealth of Australia shall combine, and form an Institution to conserve the interests of the engineering professions therein.

2. That at its inception all persons on the rolls of the associating Societies shall be entitled to enrolment in the Institution.

3. That a Provisional Council be elected, to consist of two members from each purely State Society and three from each Federal body, and that any Association has power to appoint a substitute in the event of the unavoidable absence of its representative.

4. That the Provisional Council be called together not later than 15th May, 1918, and that its first duty shall be to draft a constitution, and submit the same to the associating Societies for consideration.

5. That upon acceptance of a constitution by associating Societies, the Institution shall be deemed to be formed.

6. That on transfer to the new Institution, all section members, of whatever grade, under the age of 25 years, shall be classified as students or graduates. All section members, of whatever grade, over the age of 25 years, shall be classified as Associate Members. Associate Members over the age of 33 years may apply to the Council of the Institution for enrolment as Full Members.

7. That, in the opinion of this Conference, it is desirable that the constitution shall provide for the merging of the whole of the present Societies into a single Institution, of which the present Societies will become sections, and it is the intention of the Conference that existing Societies should, as far as possible, preserve their individuality, and that Federal control should be generally restricted to Federal matters.

8. That the choice of a title be left to the Provisional Council.

9. That it be a recommendation from this Conference that the Federal Government be asked by the Provisional Council to treat publications of scientific and technical societies and institutions as books printed in Australia, and that this resolution be transmitted to the Executive Council of the Advisory Committee of Science and Industry, asking them to take steps to bring the matter before the proper authorities.

10. That the Federal Attorney-General be requested by this Conference of the Engineering Societies of Australia to bring before his Cabinet the advisability of passing a small Bill to secure the incorporation of any Australian association or federation of scientific, technical, and professional societies.

11. That the Societies appointing delegates to the Provisional Council be asked to give them power to incur reasonable expenditure in carrying out their duties.

The Provisional Council will meet at the Royal Society's Hall, Sydney, on 14th and 15th May.

The report of the Conference was considered by the Council on 4th March when it was resolved:—

"That the Council of the Australasian Institute of Mining Engineers is desirous of assisting other Engineering Associations in every way to become a corporate body in matters Federal, but is opposed to such Institute being composed of individual members, and strongly recommends delegates to endeavour to induce other representatives to agree to a Federal Institute representing the various existing Engineering Institutes of Australia."

LIST OF PUBLICATIONS ADDED TO THE LIBRARY FROM 31ST DECEMBER, 1917 TO 31ST MARCH, 1918.

Australian Mining Standard	weekly	Melbourne
Australian Mining and Engineering Review	monthly	Melbourne
Engineering and Mining Journal	weekly	New York
Iron and Coal Trades Review	weekly	London
Mining Journal	weekly	London
Mining and Scientific Press	weekly	San Francisco
The Colliery Engineer	monthly	Scranton, Pa.
Mining and Engineering World	weekly	Chicago
Mining Magazine	monthly	London
Indian Engineering	weekly	Calcutta
Chemical News	weekly	London
South African Engineering	monthly	London
Journal of Industrial and Engineering Chemistry	monthly	Easton, Pa.
Society of Chemical Industry: Journal	bi-monthly	London
Chemical, Metallurgical and Mining Society of South Africa: Journal	monthly	Johannesburg
Franklin Institute: Journal	bi-monthly	Philadelphia
Institution of Mechanical Engineers: Journal	monthly	London
Metallurgical and Chemical Engineering	monthly	New York
Chamber of Mines of Victoria: Monthly Mining Report		Melbourne
Chamber of Mines of Western Australia: Journal	monthly	Kalgoorlie
The West Australian Mining, Building and Engineering Journal	weekly	Perth
Queensland Department of Mines: Government Mining Journal	monthly	Brisbane
Transvaal Chamber of Mines: Monthly Analysis of Production		Johannesburg
Rhodesia Chamber of Mines: Report of Executive	monthly	Bulawayo
Victorian Institute of Engineers: Proceedings, Vol. XVI.		Melbourne
Department of Mines, Victoria: Report of the Advisory Committee on Brown Coal		Melbourne
Northern Engineering Association of New South Wales: Papers, 1916-17, Vol. VIII.		Newcastle

Royal Society of Queensland:
Proceedings, Vol. XXIX. - - - Brisbane
Department of Mines, Queensland:
Geological Survey, Publications, No. 256 - Brisbane
University of Adelaide:
Calendar for 1918 - - - - Adelaide
Public Library, South Australia:
Report of the Board of Governors, 1916-17 - Adelaide
Royal Society of South Australia:
Transactions and Proceedings, Vol. XLI. - Adelaide
Department of Mines, South Australia:
Annual Report of the Director of Mines and Government Geologist, 1916 - - Adelaide
Department of Mines, Western Australia:
Geological Survey, Bulletins, Nos. 71, 73, 76 - Perth
Royal Society of Tasmania:
Papers and Proceedings, 1917 - - Hobart
Institution of Mining and Metallurgy:
Bulletins, Nos. 157–160
Transactions, Vol. XXV. - - - London
Institute of Chemistry of Great Britain and Ireland:
Proceedings, 1917, Part IV. - - London
Geological Society:
Quarterly Journal, Nos. 287 and 288 - - London
Institution of Mining Engineers:
Transactions, Vol. LIV., Part 4 - - London
Geological Survey of Great Britain:
Summary of Progress, 1916 - - London
Société Des Ingenieurs Civils De France:
Bulletin, June-September, 1917 - - Paris
Department of Mines, Canada:
Bulletin, No. 16, Part 1
Summary Report of Mines Branch, 1916
Iron Ore occurrences in Canada (2 vols.) - Ottawa
Canadian Mining Institute: Transactions, Vol. XX. - Montreal
American Institute of Mining Engineers:
Bulletins, No. 131–134 - - - New York
Secretaria De Industria Y Comercio:
Bulletin of the Department of Mines, Vol. IV., Nos. 2 and 3 - - - - Mexico

RECENT ARTICLES ON MINING MATTERS.

(31st December, 1917, to 31st March, 1918).

NOTE.—*This list is prepared for the purpose of placing before members the titles of the more important papers appearing in the usual publications concerned with mining engineering, metallurgy, &c., due regard being had to Australasian requirements.*

LIST OF PUBLICATIONS.

References are given by the number prefixed to each publication in the attached list. Wk., weekly; mth., monthly.

(1) *The Australian Mining Standard*, Melbourne, Victoria, wk., 6d.

(2) *The Queensland Government Mining Journal*, Brisbane, mth., 6d.

(3) *Metallurgical and Chemical Engineering*, New York, mth., 25c.

(4) *The Mining Journal*, London, E.C., wk. 6d.

(5) *Mining and Engineering World*, Chicago, wk., 10c.

(6) *The Engineering and Mining Journal*, New York, wk., 15c.

(7) *The Colliery Engineer*, Scranton, Pa., U.S.A., mth., 20c.

(8) *Mining and Scientific Press*, San Francisco, Cal., wk., 10c.

(9) *Annales des Mines*, Paris, France, mth.

(10) *Publications*, Department of Mines, Melbourne, Victoria.

(11) *Publications*, Department of Mines, Sydney, New South Wales.

(12) *Publications*, Department of Mines, Adelaide, South Australia

(13) *Publications*, Department of Mines, Brisbane, Queensland.

(14) *Publications*, Department of Mines, Perth, Western Australia.

(15) *Publications*, Department of Mines, Hobart, Tasmania.

(16) *Publications*, Geological Survey, Canada, Ottawa, Ontario.

(17) *Publications*, Bureau of Mines, Toronto, Ontario.

(18) *Publications*, Geological Survey of India, Calcutta.

(19) *Publications*, Geological Survey, U.S.A., Washington.

(20) *Publications*, Geological Survey, Alabama, Montgomery, Ala.

(21) *Publications*, California State Mining Bureau, Sacramento, Cal.

(22) *Reports* Anst. Assoc. Adv. Science Sydney, New South Wales.

(23) *Transactions and Proceedings*, New Zealand Inst., Wellington, New Zealand.

(24) *Quarterly Journal*, Geological Society, London.

(25) *Transactions*, Inst. Mining and Metallurgy, London, E.C.

(26) *Transactions*, Inst. Min. Eng., London.

(27) *Journal*, Canadian Mining Inst., Ottawa, Ontario.

(28) *Journal*, Chem., Min., and Met. Soc. of S.A., Johannesburg, Transvaal.

(29) *Transactions*, Am. Inst. of Min. Eng., New York City.

(30) *Proceedings*, Colorado Scientific Soc., Denver, Col.

(31) *Journal*, Franklin Inst., Philadelphia, Pa.

(32) *Australian Mining and Engineering Review* Melbourne, Vic., mth., 6d.

(33) *Transactions*, Am. Soc. C.E., New York City.

(34) *Bulletins*, Société des Ingénieurs Civils, Paris.

(35) *Mining Magazine*, 819 Salisbury House, London, E.C., mth., 1s.

(36) *Publications*, Iron and Steel Institute, London.

(37) *Proceedings*, Inst. of Mech. Eng., London.

(38) *Publications*, Field Columbian Museum Chicago, U.S.A.

(39) *Journal*, Mining Society of Nova Scotia, Halifax, N.S.

(40) *Transactions*, Mining and Geological Institute of India, Calcutta.

(41) *Publications*, Department of Mines, Wellington, N.Z.

(42) *Journal*, Chamber of Mines of West Australia, Perth.

(43) *Journal of Industrial and Engineering Chemistry*, Easton, Pa.

(44) *Proceedings*, Geologists' Association, London.

LIST OF ARTICLES.

GEOLOGICAL.

Principles Governing Zinc-Ore Deposits. F. L. Nason. (8) Nov. 3, 1917.
Microscopic Features in Silver Deposition. F. N. Guild. (8) Dec. 15, 1917.
Pressure in the Formation of Ore Deposits. S. Taber. (8) Jan. 26, 1918.
Antarctic Geology. Griffith Taylor. (35) Dec., 1917.
The Graphite Deposits at Munglinup, Eucla Division. T. Blatchford. (14) Bull. No. 76.
The Geology of North Coolgardie Goldfield. C. S. Honman. (14) Bull. No. 73.
The Geology and Mineral Resources of the Yilgarn Goldfield. T. Blatchford and C. S. Honman. (14) Bull. No. 71.
The Charters Towers Goldfield. J. H. Reid. (13) Publication No. 256.

MECHANICAL.

A Volume Regulator for Blast-Furnace Engines. L. C. Loewenstein. (3) Jan. 1. 1913.
Displacement Tanks. W. S. Weeks. (8) Dec. 15, 1917.
Hoisting-Ropes. M. H. Sigafoos. (8) Jan. 12, 1918.
Power Plant of the St. Joseph Lead Co. E. L. Broome. (6) Nov. 17, 1917.
Cage Chairs for Shaft Landings. W. F. Fancy. (6) Dec. 8, 1917.
Design and Construction of Bucket Elevators. R. Reddie. (6) Dec. 29, 1917.
A Simple Safety Device for Skips Handling Men. (6) Jan. 19, 1918.
Relative Merits of Carr and Cross Bits as Disclosed by Drilling Tests. (6) Jan. 26, 1918.
Test of a Rotary Vacuum Pump. (6) Jan. 26, 1918.
Canvas Tubing for Mine Ventilation. L. D. Frink. (29) Bull. No. 133.
The Occurrence and Testing of Foundry Moulding Sands. L. H. Cole. (27) Trans., Vol. XX.
Lubrication of Mine Machinery. J. A. Boyd. (27) Trans., Vol. XX.
Pulverized Fuel for Locomotives. J. S. Coffin. (27) Trans., Vol. XX.
The Application of Diaphragm Pumps to Metallurgical Work. L. B. Eames. (28) Oct., 1917.
Notes on the Uniflow Steam Engine. G. G. T. Poole. (26) Vol. LIV., Part 4.
Air-Lift Pumping. (37) Jan., 1918.
Heat Engines. H. R. Sankey. (37) Jan., 1918.
The Use of Soap Films in Solving Torsion Problems. A. A. Griffith and G. I. Taylor. (37). Jan., 1918.

METALLURGICAL.

Slime Treatment on Cornish Frames, with Particular Reference to the Effect of Surface. S. J. Truscott. (25) Bull. No. 158.
Comparative Concentration Tests on Wood and Fluted Glass Surfaces at Porco, Bolivia. H. A. Lewis. (25) Bull. No. 158.
A Neglected Chemical Reaction and an Available Source of Potash. E. A. Ashcroft. (25) Bull. No. 159.
Chemicals Used in Ore-Flotation. O. C. Ralston and L. D. Yundt. (3) Nov. 1, 1917.
Flotation of Chalcopyrite in Chalcopyrite–Pyrrhotite Ores of Southern Oregon. W. H. Coghill. (3) Nov. 1, 1917.
The Furnace Refining of Copper. L. Addicks. (3) Nov. 15, 1917.
Mill Sumping Systems. A. W. Allen. (3) Dec. 1, 1917.
The Future of Electrolytic Zinc. T. French. (3) Dec. 1, 1917.
The Effect of Addition Agents in Flotation. M. H. Thornberry and H. T. Mann. (3) Serial commenced Dec. 15, 1917.
Zinc Furnace Temperatures. E. M. Johnson. (3) Jan. 1, 1918.
The Physical Properties of Copper and the Factors by Which They are Affected. P. D. Merica. (3) Serial commenced Feb. 1, 1918.
Recovery of Spelter and the Treatment of Retort Residues. E. M. Johnson. (3) Feb. 1, 1918.
The Filter-Press. D. R. Sperry. (3) Feb. 1, 1918.
Sulphur Dioxide Method for Determining Copper Minerals in Partly Oxidized Ores. C. E. van Barneveld and E. S. Leaver. (3) Feb. 15, 1918.

Electric Furnace Smelting of Phosphate Rock. J. N. Carothers. (43) Jan., 1918.
Miami, Arizona: The Milling of the Ore. T. A. Rickard. (8) Nov. 10, 1917.
Factors in the Production of Electrolytic Zinc. R. G. Hall. (8) Nov. 10, 1917.
Hydro-Metallurgy of Copper Sulphides. A. E. Drucker. (8) Nov. 17, 1917.
Leaching and Purification of Zinc Sulphate. K. B. Thomas. (8) Nov. 17, 1917.
Heap-Leaching of Copper-Sulphide Ore. C. De Kalb. (8) Nov. 24, 1917.
A Flotation Patent. (8) Dec. 22, 1917.
Physics of Flotation. L. S. Ropes. (8) Dec. 29, 1917.
Heap-Leaching of Copper-Sulphide Ore. G. D. Van Arsdale. (8) Feb. 2, 1918.
Scientific Nominalism and Flotation Physics. D. H. Norris. (8) Feb. 2, 1918.
Sea Water for Flotation. (8) Feb. 2, 1918.
Copper-Leaching at Ajo. C. De Kalb. (8) Feb. 9, 1918.
Flotation of Chalcopyrite Pyrrhotite Ore. W. H. Coghill. (8) Feb. 9, 1918.
The Metallurgy of Nickel. (8) Feb. 16, 1918.
Production of Electrolytic Antimony from Impure Ores. W. A. Burr. (6) Nov. 3, 1917.
Notes on Vacuum Filtration of Flotation Concentrates. R. R. Woolley. (6) Nov. 17, 1917.
Assay Conversion Tables. A. W. Allen. (8) Nov. 17, 1917.
Losses in Zinc Metallurgy. (6) Dec. 1, 1917.
The Cascade Method of Agitation for Selective Flotation of Sulphides. (6) Dec. 8, 1917.
Cyaniding a Small Gold-Tailings Dump. A. W. Allen. (6) Dec. 15, 1917.
Development of Reverberatory Practice at Copper Cliff, Ont. C. F. Mason. (6) Dec. 22, 1917.
Sampling of Mine Floors. A. G. Wolf. (6) Dec. 29, 1917.
Some Experiments in Heap-Leaching Copper Ores. G. D. Van Arsdale. (6) Feb. 2, 1918.
Sulphur and Copper Oxide Determination. C. G. Maier. (6) Feb. 23, 1918.
Notes on the Disadvantage of Chrome Brick in Copper Reverberatory Furnaces. F. R. Pyne. (29) Bull. No. 132.
Slag Viscosity Tables for Blast-Furnace Work. A. L. Field and P. H. Royster. (29) Bull. No. 132.
Temperature-Viscosity Relations in the Ternary System $CaO - Al_2O_3 - SiO_2$. A. L. Field and P. H. Royster. (29) Bull. No. 132.
Recent Tests of Ball-Mill Crushing. C. T. Van Winkle. (29) Bull. No. 133.
Sodium Sulphide Precipitation of Silver. R. B. Watson. (27) Trans., Vol. XX.
Milling Practice at the Buffalo Mines, Cobalt, Ont. R. E. Dye. (27) Trans., Vol. XX.
Present Flotation Practice on Cobalt Ores. J. M. Callow and E. B. Thornhill. (27) Trans., Vol. XX.
Canadian Wood Oils for Flotation. C. S. Parsons and R. E. Gilmore. (27) Trans., Vol. XX.
Notes on Milling Practice at the M'Intyre Mine, Porcupine, Ont. A. Dorfman. (27) Trans., Vol. XX.
Local Treatment for Certain West Kootenay Silver Ores. F. A. Thomson. (27) Trans., Vol. XX.
The Concentration and Marketing of Canadian Molybdenite. H. H. Claudet. (27) Trans., Vol. XX.
Electro-Deposition of Zinc from Aqueous Solutions. E. P. Mathewson. (27) Trans., Vol. XX.
Electrolytic Zinc in Eastern Canada. E. E. Watts. (27) Trans., Vol. XX.
The Formation of Zinc Ferrate. E. H. Hamilton, G. Murray, and D. M'Intosh. (27) Trans., Vol. XX.
Countercurrent Decantation. L. B. Eames. (27) Trans., Vol. XX.
The Partridge Smelting Furnace. A. R. Partridge. (27) Trans., Vol. XX.
Concentration of Tin Gravels. W. W. Richardson. (35) Oct., 1917.
The Taylor Concentrator for Tin Slimes. J. W. Partington. (35) Dec., 1917.
East Poole Dressing Practice. (35) Dec., 1917.
Alluvial Tin Mining. (35) Dec., 1917.
A New Method of Determining Copper. J. Moir. (28) Nov., 1917.
Manufacture of Crude Sodium Manganate for Use on the Mines. F. Wartenweiler. (28) Jan., 1918.

MINING.

Tin Dredging in Portugal. F. W. Foote and R. S. Ransom. (6) Dec. 29, 1917.
Use of Powder in Open-Cut Blasting. E. S. Jacobson. (6) Feb. 28, 1918.
Branch Raise System at the Ruth Mine, Nevada Consolidated Copper Co. W. S. Larsh. (29) Bull. No. 133.

MISCELLANEOUS.

Laboratory Methods for Benzol-Recovery Plant Operation. F. W. Sperr. (3) Serial commenced Nov. 1, 1917.
Intensive Toluol Production. F. E. Lichtenthaeler. (3) Serial commenced Feb. 1, 1918.
Ajo Copper Mine. C. De Kalb. (8) Serial commenced Jan. 26, 1918.
The Duties of a Shift Boss. J. P. Hodgson. (8) March 2, 1918.
Drift Mining in California. J. D. Hubbard. (6) Nov. 17, 1917.
Economic Importance of Wood Preservation. K. C. Barth. (6) Dec. 8, 1917.
Memorandum of War Excess Profits Tax. (6) Dec. 15, 1917.
Considerations in the Selection and Use of Hoisting Ropes. (6) Dec. 22, 1917.
Re-dredging: Will It Pay? W. H. Gardner. (6) Jan. 5, 1918.
Depletion and Depreciation. (6) Jan. 26, 1918.
Briquetting of Anthracite Coal. W. P. Frey. (29) Bull. No. 133.
Measures for Controlling Fires at the Copper Queen Mine. G. Sherman. (29) Bull. No. 133.
The Present Position and Future of the Iron and Steel Industries in Canada. C. F. Whitton. (27) Trans., Vol. XX.
Some Suggestions on Filing and Indexing. F. E. Lathe. (27) Trans., Vol. XX.
Electric Winding for Mines. W. R. Evans. (35) Oct., 1917.
The Kanbank Wolfram Mine, Lower Burma. H. D. Griffiths. (35) Nov., 1917.
The Broken Hill South Mine. W. E. Wainwright and P. H. Warren. (35) Jan., 1918.
University Education in Relation to Mining Engineering. W. Ripper. (26) Vol. LIX., Part 4.

SUBSCRIPTIONS.

Members are reminded that Subscriptions for 1918 are due, and are requested to forward same as early as possible.

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PROCEEDINGS

OF THE

AUSTRALASIAN

Institute of Mining Engineers.

NEW SERIES.

No. 30.

EDITED BY THE SECRETARY.

This Institute is not responsible, as a body, for the facts and opinions advanced in any of its publications.

30th JUNE, 1918.

PUBLISHED QUARTERLY BY THE AUSTRALASIAN INSTITUTE OF MINING ENGINEERS, MELBOURNE.

Australasian Institute of Mining Engineers.

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The Executive Committee consists of all Members of the Council residing, or for the time being, in Melbourne.

Head Office:

57-59 Swanston Street, Melbourne, Victoria.

Institute Matters.

CONTENTS.

	Page
Minutes of Meetings—	
Of the Executive Committee - - - - -	xxv
Notices - - - - - - - -	xxvii
Publications—Added to Library - - - - -	xxxi
Recent Articles—On Mining Matters - - - -	xxxiv

MINUTES OF MEETINGS.

Of the Executive Committee.

(Summary.)

April 8th, 1918—1 p.m.

The Secretary's report was presented and accounts to the amount of £25 were passed for payment.

Resolved that the suggestion to hold the First Ordinary Meeting, 1918, at Kalgoorlie be abandoned and that enquiries be made regarding the possibility of holding the meeting at Newcastle, N.S.W. The matter was referred to a special committee with power to act.

A report in connection with the matter of Commissions in the A.I.F. was submitted and further enquiries directed to be made thereon.

A letter was read from the Federal Attorney-General expressing doubt regarding the Commonwealth's power to legislate in the direction desired by the Institute, viz., to put a small Bill through Parliament which would enable the Institute to incorporate as a Federal body. Resolved that steps be taken to determine the point definitely.

A report was submitted of applications made by students under the provisions of the Mining and Metallurgical Bursaries Fund.

Other routine business was transacted.

MAY 13TH, 1918—1 P.M.

The Secretary's report was presented and accounts to the amount of £42 passed for payment.

Further consideration was given to the matter of Commissions in the A.I.F.

Resignation of Mr. Isidore Tom was accepted with regret.

Resolved that the Mining and Metallurgical Bursaries Committee be approached in respect to a proposal submitted that the Bursaries, &c., apply also to the Sydney University.

Messrs. F. Danvers Power and Wm. Poole were appointed to act on the Provisional Council, *re* proposed amalgamation of engineering bodies, in place of Messrs. H. H. Schlapp and A. S. Kenyon who were unable to proceed to Sydney to attend the meetings on May 15th and 16th.

The meetings' Sub-Committee reported that notices had been issued convening the First Ordinary Meeting, 1918: the meeting to be held at Newcastle, N.S.W., commencing on August 24th and terminating on August 29th.

JUNE 10TH, 1918—1 P.M.

The Secretary's report was presented and accounts to the amount of £47, including printing £21, were passed for payment.

The following were elected to the Institute:—Members—Messrs. John Joice, Essington Lewis and Thomas Andrew Read; Student—Mr. Frederick Thomas Kerr.

Resolved that the Prime Minister of Australia be informed that the Institute is willing to form an Honorary Advisory Committee to assist the Commonwealth Government in mining and metallurgical matters in connection with National Organisation arising out of the war.

The appointment of a local committee to make local arrangements in connection with the Newcastle meeting was endorsed. A progress report in connection with the meeting was submitted.

Other routine business was transacted.

NOTICES.

The rooms of the Institute are open from 9.30 A.M. to 10 P.M. daily, except Sundays and Public Holidays.

MEMBERSHIP.

Since the last issue of Proceedings the following have been admitted to the Institute :—

MEMBERS.

Names and Addresses.

Joice, John, Leonora Gold Blocks, Leonora, W.A.

Lewis, Essington, c/o Broken Hill Proprietary Co. Ltd., 320 Collins-st., Melbourne.

Read, Thomas Andrew, "Warrawee," Thomas-st., Broken Hill, N.S.W.

ON ACTIVE SERVICE.

Professor D. B. Waters (Capt.) who left New Zealand with the Tunnelling Co. has returned after two years service, including eighteen months in France. As the result of gas he was in hospital in France for some time. He returned to New Zealand in charge of a transport.

Stanley Hunter (Capt.) has been invalided home and is now in the Caulfield Hospital. He left Melbourne with the First Mining Corps.

E. P. Hargraves (Lieut.) returned to Melbourne in June suffering from the effects of gas. He was for some time in the Wandsworth Hospital, London.

V. C. Bennett (Lieut.) was invalided home and is now in Melbourne. He is making good recovery.

Harold Rabling, who left Australia with the 3rd Pioneers, is reported to have been gassed.

E. Foulkes Taylor is a Lieutenant in the Royal Engineers.

Honors Won.

R. J. Donaldson (Major) of the Central Mine, Broken Hill, has been awarded the D.S.O. Major Donaldson is a son of Mr. and Mrs. R. G. Donaldson, of Camberwell, Vic., and is attached to the 11th Co. Field Engineers.

Killed in Action.

Lieut. Norman Ford is reported to have been killed in action on April 5 last, at the age of 27. He was formerly a student at the Charters Towers School of Mines and later assayer with the Chillagoe Co. On the outbreak of war he went to German New Guinea as a member of the Military Force which captured that territory; he then went to Africa, obtaining a position with the Tarquah mines. Later, whilst on leave in England, he enlisted and gained his commission as Second Lieutenant in the Royal Engineers. After nine months at the Front he obtained permission to transfer to the Flying Corps. He went to France as an observer in March.

MOVEMENTS OF MEMBERS.

O. B. Ward has, on account of ill-health, resigned from the management of Block 10 Co., Broken Hill.

W. S. Jensen, late officer in charge of Many Peaks Mine, is now mine manager, Mount Morgan Mine.

C. Lonsdale Smith has been appointed manager of the Macdonald Kitchener Molybdenite Mines, Almaden, North Queensland.

E. J. Rigby is now in the United States of America and is interesting himself in ship-building.

A. S. Lilburne is in Western Australia reporting on the Mary Mac Gold Mine, Laverton, and on the property of the Yilgarn Consols Co. at Burtville in the same district.

Mr. Gordon L. A. Ditchburn, late of the Ivanhoe Corporation, Boulder, W.A., has accepted a position with the Pahang Consolidated Co., Federated Malay States.

A. E. Kitson who, prior to 1906, was senior field geologist of the Geological Survey Department of Victoria, has for some years occupied the position of Director, Geological Survey Department, Gold Coast. As a recognition of the value of his work Mr. Kitson has recently had conferred upon him the distinction of Commander of the British Empire.

FIRST ORDINARY MEETING, 1918—NEWCASTLE.

It has been decided that the First Ordinary Meeting, 1918, be held at Newcastle and arrangements in connection with the meeting are now well in hand. A most interesting programme has been made out. Members should notify the Secretary as early as possible of their intention to be present. A good attendance is already assured, and it is expected that all of the States will be represented at the meeting. The main items on the programme are :—

Saturday, 24th—	5.9 p.m.	Arrive at Newcastle
Sunday. 25th—	Morning	Free.
	Afternoon	Excursion to Lake Macquarie (or Harbour Excursion).
Monday, 26th—	8.30 a.m.	Visit to Steel Works.
	1 p.m.	Lunch at Works.
	2 p.m.	Visit to Steel Works (continued)
	8 p.m.	Reading and Discussion of papers
Tuesday, 27th—	9 20 a.m.	Visit to Cockle Creek Smelting Works.
	1 p.m.	Lunch at Works.
	2 p.m.	Visit to Cockle Creek Smelting Works (continued).
	8 p.m.	Reading of Papers.
Wednesday, 28th—	9 a.m.	All day trip to Cessnock, to visit Aberdare and Aberdare Extended Collieries.
	8 p.m.	Institute Dinner.
Thursday, 29th—	9 a.m.	Visit to State Ship-building Yard, Walsh Island.
	2 p.m.	Geological Excursion.
	8 p.m.	Reading and Discussion of papers.
Friday, 30th—	9.50 a.m.	Depart for Sydney.

Titles of papers listed for reading and discussion include :—

"Manufacture of Cement from Iron Blast-Furnace Slag," by Wm. Poole.

"The Coal Industry of New South Wales," by A. A. Atkinson.

"Illustrated Description of the various plants in operation at the Cockle Creek Smelting Works (Sulphide Corporation Ltd.), New South Wales."

(*a*) Introductory by C. F. Courtney (General Manager).

(*b*) "Short Description of the Method of Discharging and Sampling Ore Received," by Thomas Lawrie.

(*c*) "A Brief Description of the New Assay Office," by E. Strangway-Jones.

(*d*) "Description of the Roasting of Sulphide Ore by the Huntington-Heberlein Process," by W. J. Jackson.

(*e*) "Description of the Sulphuric Acid, Nitric Acid and Superphosphate Plants," by J. H. McFeeters.

(*f*) "A Brief Résumé of the Sulphide Corporation's Smelting Plant," by Guy Courtney.

(*g*) "Description of Lead Refinery," by R. E. Cowles.

(*h*) "Description of the Mond By-Product Gas Plant," by F. S. Sanderson.

(*i*) "Short Description of the Tar Distillation Plant," by H. Gatley Lyon.

"Intensive Boring on the Wonthaggi Field, Vic.," by H. Herman.

"An Improved Method of Dumping Spoil," by Geo. H. Broome.

"New Phosphate Deposit in the Howqua District, Vic.," by Professor E. W. Skeats and E. O. Teale.

"Some Notes on the Geology of Stannary Hills, North Queensland," by G. B. Hope.

Titles of other papers promised will be given later. As many papers as possible will be printed and advance copies issued prior to the meeting to members attending the meeting, thus affording a good opportunity for discussion.

PROPOSED AMALGAMATION OF ENGINEERING BODIES.

The Provisional Council, appointed at a Conference of Representatives of Engineering Institutes, held in Melbourne in February last, met in Sydney on 15th and 16th May for the purpose of framing a Constitution on the lines recommended by the Conference. The Council of the Australasian Institute of Mining Engineers was represented at the meeting in Sydney; it being clearly understood that this Institute would not agree to amalgamation, as proposed, but favored federation. A report of the meeting and a copy of the proposed Constitution should shortly be forthcoming.

NATIONAL ORGANISATION.

The Council has notified the Prime Minister of Australia that the Institute is willing to form an Advisory Committee to assist the Commonwealth Government in mining and metallurgical matters in connection with National Organisation arising out of the war.

OBITUARY.

It is with regret that the announcement is made of the death of Mr. August Simson which occurred at his home in Launceston. Mr. Simson was a Foundation Member of the Institute.

LIST OF PUBLICATIONS ADDED TO THE LIBRARY

From 31st March to 30th June, 1918.

Australian Mining Standard	weekly	Melbourne
Australian Mining and Engineering Review	monthly	Melbourne
Engineering and Mining Journal	weekly	New York
Iron and Coal Trades Review	weekly	London
Mining and Scientific Press	weekly	San Francisco
The Colliery Engineer	monthly	Scranton, Pa.
Mining and Engineering World	weekly	Chicago
Mining Magazine	monthly	London
Indian Engineering	weekly	Calcutta
Chemical News	weekly	London
South African Engineering	monthly	London
Journal of Industrial and Engineering Chemistry	monthly	Easton, Pa.
Society of Chemical Industry : Journal	bi-monthly	London
Chemical, Metallurgical and Mining Society of South Africa : Journal	monthly	Johannesburg
Franklin Institute : Journal	bi-monthly	Philadelphia
Institution of Mechanical Engineers : Journal	monthly	London
Metallurgical and Chemical Engineering	monthly	New York
Chamber of Mines of Western Australia : Journal	monthly	Kalgoorlie
The West Australian Mining, Building and Engineering Journal	weekly	Perth
Queensland Department of Mines : Government Mining Journal	monthly	Brisbane
Transvaal Chamber of Mines : Monthly Analysis of Production		Johannesburg
Rhodesia Chamber of Mines : Report of Executive	monthly	Bulawayo
Royal Society of Victoria : Proceedings, Vol. XXX., Part II.		Melbourne
Engineering Association of New South Wales : Proceedings, Vol. XXXII.		Sydney
Royal Society of New South Wales : Proceedings, Vol. L., Parts 1-3		Sydney

Department of Mines, Queensland :
Geological Survey, Publications, Nos. 255, 258, 261 Brisbane
Department of Mines, South Australia :
Mining Review, No. 27 - - - Adelaide
South Australian Institute of Engineers :
Proceedings, 1916-1917 - - - Adelaide
Department of Mines, Western Australia :
Geological Survey, Bulletin, No. 74 - - Perth
Department of Mines, Tasmania :
Geological Survey, Bulletin, Nos. 26 and 27 - Hobart
New Zealand Journal of Science and Technology :
Vol., I., Nos. 1 and 2 - - - Wellington
Geological Survey of New Zealand :
Bulletins, Nos. 19 and 20 - - Wellington
New Zealand Institute :
Transactions, Vol. XLIX., 1916 - - Wellington
Institution of Chemistry of Great Britain and Ireland :
Proceedings, 1918, Parts I. and II. - - London
Iron and Steel Institute :
Journal, No. 2, 1917 - - - London
Geological Society :
Quarterly Journal, No. 289 - - London
Institution of Mining Engineers :
Transactions, Vol. LIII., Part 5; Vol. LIV., Part 5; Vol. LV., Part 1 - - London
Institution of Mining and Metallurgy :
Bulletins, Nos. 161 and 162 - - London
North of England Institute of Mining and Mechanical Engineers : Annual Report, 1917-18 - London
Société Des Ingenieurs Civils De France :
Bulletin, October-December, 1917 - - Paris
Geological Survey of India :
Records, Vol. XLVIII., Parts 3 and 4 - Calcutta
Mysore Geological Department :
Records, Vol. XV., 1916, Part 2 - - Mysore
Bureau of Mines, Ontario, Canada :
26th Annual Report, Vol. XXVI., 1917 - Toronto
Department of Mines, Canada :
Memoirs, Nos. 99, 100 and 102
Iron Ore Occurrences in Canada, Vol. 2 - Ottawa

American Society of Civil Engineers:
Transactions, Vol. LXXXI. - - New York
American Institute of Mining Engineers:
Bulletins. No. 135-137 - - - New York
Secretaria De Industria Y Comercio:
Bulletin of the Department of Mines, Vol. IV., Nos. 4-6; Vol. 5, No. 1 - - Mexico
Cuerpo de Ingenieros de Minas:
Bulletin, Nos. 84, 86, 88 - - - Peru

SUBSCRIPTIONS.

Members are reminded that Subscriptions for 1918 are due, and are requested to forward same as early as possible.

RECENT ARTICLES ON MINING MATTERS.

(31st March, 1918, to 30th June, 1918).

NOTE.—*This list is prepared for the purpose of placing before members the titles of the more important papers appearing in the usual publications concerned with mining engineering, metallurgy, &c., due regard being had to Australasian requirements.*

LIST OF PUBLICATIONS.

References are given by the number prefixed to each publication in the attached list. Wk., weekly; mth., monthly.

(1) *The Australian Mining Standard*, Melbourne, Victoria, wk., 6d.

(2) *The Queensland Government Mining Journal*, Brisbane, mth., 6d.

(3) *Metallurgical and Chemical Engineering*, New York, mth., 25c.

(4) *The Mining Journal*, London, E.C., wk., 6d.

(5) *Mining and Engineering World*, Chicago, wk., 10c.

(6) *The Engineering and Mining Journal*, New York, wk., 15c.

(7) *The Colliery Engineer*, Scranton, Pa., U.S.A., mth., 20c.

(8) *Mining and Scientific Press*, San Francisco, Cal., wk., 10c.

(9) *Annales des Mines*, Paris, France, mth.

(10) *Publications*, Department of Mines, Melbourne, Victoria.

(11) *Publications*, Department of Mines, Sydney, New South Wales.

(12) *Publications*, Department of Mines, Adelaide, South Australia.

(13) *Publications*, Department of Mines, Brisbane, Queensland.

(14) *Publications*, Department of Mines, Perth, Western Australia.

(15) *Publications*, Department of Mines, Hobart, Tasmania.

(16) *Publications*, Geological Survey, Canada, Ottawa, Ontario.

(17) *Publications*, Bureau of Mines, Toronto, Ontario.

(18) *Publications*, Geological Survey of India, Calcutta.

19) *Publications*, Geological Survey, U.S.A., Washington.

(20) *Publications*, Geological Survey, Alabama, Montgomery, Ala.

(21) *Publications*, California State Mining Bureau, Sacramento, Cal.

(22) *Reports* Aust. Assoc. Adv. Science, Sydney, New South Wales.

(23) *Transactions and Proceedings*, New Zealand Inst., Wellington, New Zealand.

(24) *Quarterly Journal*, Geological Society, London.

(25) *Transactions*, Inst. Mining and Metallurgy, London, E.C.

(26) *Transactions*, Inst. Min. Eng., London.

(27) *Journal*, Canadian Mining Inst., Ottawa, Ontario.

(28) *Journal*, Chem., Min., and Met. Soc. of S.A., Johannesburg, Transvaal.

(29) *Transactions*, Am. Inst. of Min. Eng., New York City.

(30) *Proceedings*, Colorado Scientific Soc., Denver, Col.

(31) *Journal*, Franklin Inst., Philadelphia, Pa.

(32) *Australian Mining and Engineering Review*, Melbourne, Vic., mth., 6d.

(33) *Transactions*, Am. Soc. C.E., New York City.

(34) *Bulletins*, Société des Ingénieurs Civils, Paris.

(35) *Mining Magazine*, 819 Salisbury House, London, E.C., mth., 1s.

(36) *Publications*, Iron and Steel Institute, London.

(37) *Proceedings*, Inst. of Mech. Eng., London.

(38) *Publications*, Field Columbian Museum, Chicago, U.S.A.

(39) *Journal*, Mining Society of Nova Scotia, Halifax, N.S.

(40) *Transactions*, Mining and Geological Institute of India, Calcutta.

(41) *Publications*, Department of Mines, Wellington, N.Z.

(42) *Journal*, Chamber of Mines of West Australia, Perth.

(43) *Journal of Industrial and Engineering Chemistry*, Easton, Pa.

(44) *Proceedings*, Geologists' Association, London.

LIST OF ARTICLES.

MECHANICAL.

Testing an Air-Compressor. W. S. Weeks. (8) April 6, 1918.
By-Product Coke Oven and its Products. W. H. Blanvelt. (29) Bull. No. 135.
The Use of Coal in Pulverized Form. H. R. Collins. (29) Bull. No. 136.

METALLURGICAL.

Estimation of Manganese in Aluminium Alloys and Dust. J. E. Clennell. (6) March 2, 1918.
Flotation of Chalcopyrite in Chalcopyrite–Pyrrhotite Ores of Southern Oregon. W. H. Coghill (6) March 2, 1918.
U.S. Metals Refinery Co.'s New Laboratory at Chrome N.J. B. B. Hood. (6) March 9, 1918
Concentration of Chrome Ores. (6) March 9, 1918.
Utah Leasing Company's Flotation Plant at Newhouse, Utah. H. H. Adams. (6) March 23, 1918.
Methods for Determining Copper Minerals in Partly Oxidized Ores. C. E. Van Barneveld and E. S. Leaver. (6) March 23, 1918.
Quantitative Analysis of Bismuth in Lead Bullion. D. W. Jessup. (6) March 30, 1918.
Flotation in the Cœur d'Alenes. C. T. Rice. (6) April 20, 1918.
Flotation in Arizona. R. Gahl. (6) April 20, 1918.
Flotation at Belmont Surf Inlet Mines. A. H. Jones. (6) April 20, 1918.
Handling Flotation Concentrates at Utah Leasing Co.'s Plant. H. H. Adams. (6) April 20, 1918.
Milling Practice and Operating Costs in the Joplin District. H. W. Kitson. (6) April 20, 1918.
Troubles in Flotation. O. C. Ralston. (6) April 20, 1918.
Flotation in Relation to Gangue Minerals. J. M. M'Clave. (6) April 20, 1918.
Selective Flotation in Australia. Guy C. Riddell. (6) April 20, 1918.
Differential Flotation of Lead and Zinc. W. L. Zeigler. (6) April 20, 1918.
Flotation *v.* Cyanidation. G. H. Clevenger. (6) April 20, 1918.
The Ruth Flotation Machine. J. P. Ruth. (6) April 20, 1918.
Flotation of Semi-Oxidized Silver Ore. E. J. Atchison. (8) April 27, 1918.
Chart for Tonnage-Sampling and Dilution Control. H. R. Robbins. (8) April 27, 1918.
Classification of Furnace Slags. H. Lang. (8) May 4, 1918.
Improved Flotation Drier. S. Paul Lindau and W. E. Evans. (8) May 11, 1918.
Converting an Agitator into a Continuous Thickener. V. T. Edquist. (8) May 11, 1918.
Smelting Methods at El Pasco. C. De Kalb. (8) May 25, 1918.
New Method of Determining Copper. J. Moir. (8) May 25, 1918.
Sacramento Hill Disseminated Copper Deposit. C. De Kalb. (8) April 20, 1918.
Cascade Method of Froth-Flotation. H. Hardy Smith. (8) April 13, 1918.
Roasting Zinc Ore for Leaching. F. D. James. (8) April 13, 1918.
Loss of Quicksilver in Gold Mills. W. J. Sharwood. (8) April 6, 1918.
Calumet and Arizona Sulphuric Acid Plant. C. De Kalb. (8) March 30, 1918.
The Humboldt Roasting Plant. A. A. Watson. (8) March 9, 1918.
The 2,000-Ton Leaching Plant at Anaconda. F. Laist and H. J. Maguire. (8) March 16, 1918.
The Effect of Addition Agents in Flotation. M. H. Thornberry and H. T. Mann. (3) March 1, 1918.
Plate and Frame Filtration. D. R. Sperry. (3) March 1, 1918.
Nitric Acid and Copper Ore. G. C. Westby. (3) March 15, 1918.
Recovering Ammonia at Tar-Distilling Plants. C. R. Woodward. (3) March 15, 1918.
Physical Properties of Copper and the Factors by Which They are Affected. P. D. Mercia. (3) March 15, 1918.
Simple Washing in the Filter-Press. D. R. Sperry. (3) April 1, 1918.
Milling in Cyanide Solution. A. W. Allen. (3) May 15, 1918.
Washing in Filter-Presses. D. R. Sperry. (3) May 15, 1918.
Manufacture of Nitric Acid. (3) May 15, 1918.

The Application of Charcoal in the Precipitation of Gold from its Solution in Cyanide. H. R. Edmands. (25) Bull. No. 161.
Blast-Furnace Smelting of Stibnite, with Considerations of the Metallurgy of Antimony. W. R. Schoeller. (25) Bull. No. 161.
Electrolytic Zinc. C. A. Hansen. (29) Bull. No. 135.
Oxygen v. Sulphur in the Melting of Copper Cathodes. S. Skowronski. (29) Bull. No. 135.
The Relation of Sulphur to the Overpoling of Copper. S. Skowronski. (29) Bull. No. 135.
Hand-Sorting of Mill Feed. R. S. Hardy. (29) Bull. No. 136.
The Practice of Antimony Smelting in China. Chung Yu Wang. (29) Bull. No. 136.

MINING.

Steam Shovel Mining on the Mesabi Range. L. D. Davenport. (6) Serial commenced March 2, 1918.
The Mining Districts of Joplin and South-East Missouri. H. W. Kitson. (6) March 2, 1918.
The Incline Top-Slice Method Applied to Large Ore-Bodies. (6) March 9, 1918.
Cement Gun in Mining Work. G. S. Rice. (6) March 30, 1918.
Siphon to Unwater a Mine. J. A. MacDonald. (6) March 30, 1918.
Use of the Cement Gun in the Coeur d'Alene Mining District. (6) April 27, 1918.
Drawing Pillars in Metal Mines. W. R. Crane. (8) March 23, 1918.
Fireproofing Mine Shafts of the Anaconda Copper Mining Co. E. M. Norris. (29) Bull. No. 153.

MISCELLANEOUS.

Gibbs Oxygen Rescue Apparatus. (6) Feb. 16, 1918.
The Bonus System Applied to Mining. W. V. De Camp. (6) March 9, 1918.
Smelting and Ore-Sales Investigations in Colorado. (6) March 23, 1918.
Air-Controlled Fire Door at Copper Queen Mine. (6) March 28, 1918.
Application of Federal Income Tax Laws to Mine Taxation. (6) April 6, 1918.
The Work of the Petroleum Geologist. G. E. Burton. (6) May 4, 1918.
Standardization of Directors' Reports for Mining Companies. T. O. M'Grath. (6) March 4, 1918.
The Gold Industry and the Gold Standard. H. Jennings. (8) May 11, 1918.
Hydro-Electric Power in Relation to Industry. J. A. Johnson. (8) May 1, 1918.
The Crippled Soldier in Industry. F. B. Gilbreth. (29) Bull. No. 136.

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NEW SERIES.

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This Institute is not responsible, as a body, for the facts and opinions advanced in any of its publications.

30th SEPTEMBER, 1918.

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Australasian Institute of Mining Engineers.

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The Executive Committee consists of all Members of the Council residing, or for the time being, in Melbourne.

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48 Queen Street, Melbourne, Victoria.

Institute Matters.

CONTENTS.

MINUTES OF MEETINGS—	Page
Of the Institute	xxxvii
Of the Executive Committee	lvii
NOTICES	lx
PUBLICATIONS—Added to Library	lxvii
RECENT ARTICLES—On Mining Matters	lxix

MINUTES OF MEETINGS.

OF THE INSTITUTE.

First Ordinary Meeting, 1918, Newcastle, N.S.W.

24TH AUGUST TO 29TH AUGUST.

THE response to the circular and programme announcing the Council's decision to hold the First Ordinary Meeting, 1918, at Newcastle was most satisfactory. The attendance was large and representative of all branches of mining and metallurgy. Altogether, 68 members and 62 students were present. All of the Australian States, New Zealand, and New Guinea were represented. A special feature of the meeting was the large attendance of students from the Universities of Melbourne, Sydney, and Adelaide; the Schools of Mines of Adelaide, Bendigo, and Bairnsdale; the Technical Schools of Moonta, Mount Morgan, Melbourne, and Brisbane. Mines Departments were represented as follows:—New Zealand by the Under-Secretary for Mines (Mr. H. J. H. Blow), and Messrs. Boyd Bennie and J. F. Downey, Inspectors of Mines for the North and South Islands respectively; New South Wales by the Hon. the Minister for Mines; South Australia by Mr. L. Keith Ward, Director of Mines; Tasmania by Mr. J. O. Hudson, Chief Inspector of Mines; and Victoria by Mr. H. Herman, Director of Geological Survey.

Saturday, 24th August.

The party arrived by train at Newcastle at about 6.45 p.m., and was met by Messrs. C. A. Süssmilch and D. N. Morison, representatives of the local committee.

At 7.30 p.m. the visitors were accorded a civic reception in the Newcastle Council Chambers by the Mayor, Alderman A. G. Kilgour; the town clerk, Mr. E. Scott Holland; Mr. Richard Thomas, representing the Northern Engineering Institute; Mr. A. Goninan, representing the Manufacturers' Association, and other prominent citizens. Professor E. W. Skeats, Councillor, on behalf of the visitors, acknowledged the very hearty welcome.

At the invitation of the Northern Engineering Institute members then adjourned to St. Philip's Hall, where Mr. A. Goninan delivered a lecture on "Engineering Impressions During My Recent Trip Through America and England."

Sunday, 25th August.

Members spent the morning in a quiet survey of the town. The 2.15 p.m. train was taken for Toronto, where three motor launches were placed at the disposal of the party by Messrs. D. M'Geachie and W. Webb. After an enjoyable short journey on Lake Macquarie the party returned to Newcastle.

Monday, 26th August.

At 8.30 a.m. members were conveyed by steamer from Stockton ferry wharf, at the foot of Market Street, to the Broken Hill Proprietary Co.'s steel works. There the party was divided into sections, each in charge of a member of the Company's staff. Mr. G. D. Delprat (general manager), Mr. D. Baker (works manager), Mr. J. M'Meaking (assistant manager), Mr. Noyes (superintendent of plant), and Mr. K. Galbraith (constructional engineer), accompanied the parties. Copies of a short description of the works, specially written for the occasion and supplied to each member by the general manager, made plain the extent and great possibilities of the company's undertaking.

First Ordinary Meeting, 1918—Members at Cockle Creek Smelting Works

The inspection lasted all day. Luncheon was provided by the company in fine style in a huge marquee. Mr. G. D. Delprat, general manager, presided; on his right was seated the Hon. the Minister for Mines for New South Wales (Mr. Fitzpatrick), and on his left Mr. H. Herman, ex-President, who was appointed leader of the party in the unavoidable absence of the President (Mr. J. W. Sutherland). Following the toast of "The King," Mr. Delprat extended a very hearty welcome to the visitors. Mr. James Hebbard (Broken Hill) proposed "Prosperity to the Broken Hill Proprietary Company Ltd." Mr. Delprat, in acknowledging the toast, specially referred to the excellent work of his staff.

The following is a summary of the main points of interest at the works:—

These works are situated at Port Waratah, near the city of Newcastle, N.S.W., and over 380 acres of land have been acquired by the company for the establishment of their up-to-date steel works.

The first instalment of plant arrived in Newcastle from America in January, 1914, and the works were officially opened by the Governor-General of Australia on 2nd June, 1915. Up to the middle of 1918 the sum of £2,800,000 had been spent in developing this huge industry.

The River Hunter has been deepened to 25 ft. to enable large steamers to carry their cargoes of iron ore to the works, and a wharf frontage of 1300 ft. is now continually in use. The iron ore is obtained from the Iron Knob quarries, which are situated near Spencer's Gulf, in South Australia.

The ore is delivered to the works in large steamers, and is discharged by means of two electrically-operated grabs.

Blast Furnaces.—The blast furnace at present in use has a capacity of 500 tons of pig iron per day. It is provided with a Baker–Newman rotary distributor, which spreads the lumps and fines forming the charge automatically and equally about the receiving bell of the furnace. The waste gas from the top of the furnace, after being washed, is distributed to four hot-air stoves of the Cowper type. These stoves are each 21 ft. in diameter and 90 ft. high, and the blast on its way to the furnace is heated in the stoves to an average temperature of 1300° Fahr. The surplus of the waste gas from the blast furnace is conducted to Babcock and Wilcox boilers, which furnish the power for operating the blast-furnace blowing engines.

The blast furnace is tapped every four hours for a quantity of metal of from 60 to 80 tons per tap.

The second blast furnace is now nearly completed, and is of a similar capacity to the above mentioned. This furnace has been wholly constructed at the steel works, all the large steel castings having been done on the premises. It is proposed to instal a Rateau blower to supply the necessary air-blast for this furnace.

Foundry Furnace.—This consists of a smaller furnace having a capacity of 80 to 100 tons of pig iron per day, and is producing pig iron entirely for iron-foundry work.

Steel Furnaces.—These consist of seven 65-ton basic open-hearth furnaces of the stationary type. In connection with the open-hearth furnaces is a mixer of a capacity of 1000 tons. The pig iron from the blast furnace is conveyed to the mixer in large ladles. The mixer is of the revolving type, and supplies, when required, the necessary hot metal to the open-hearth furnaces. The steel is tapped from the back of the open-hearth furnaces and runs into a large steel ladle. This ladle is lifted by a 100-ton overhead travelling crane, and the steel is teemed into large ingot moulds and is conveyed in the form of ingots to the blooming mill.

In cases of pig iron produced by the blast furnace being over the requirements of the steel plant, it is dealt with in the pig-casting machine. This machine consists of a belt of moulds into which the pig iron is poured. The moulds pass under sprays of water, and the pig bars are delivered at the other end of the machine.

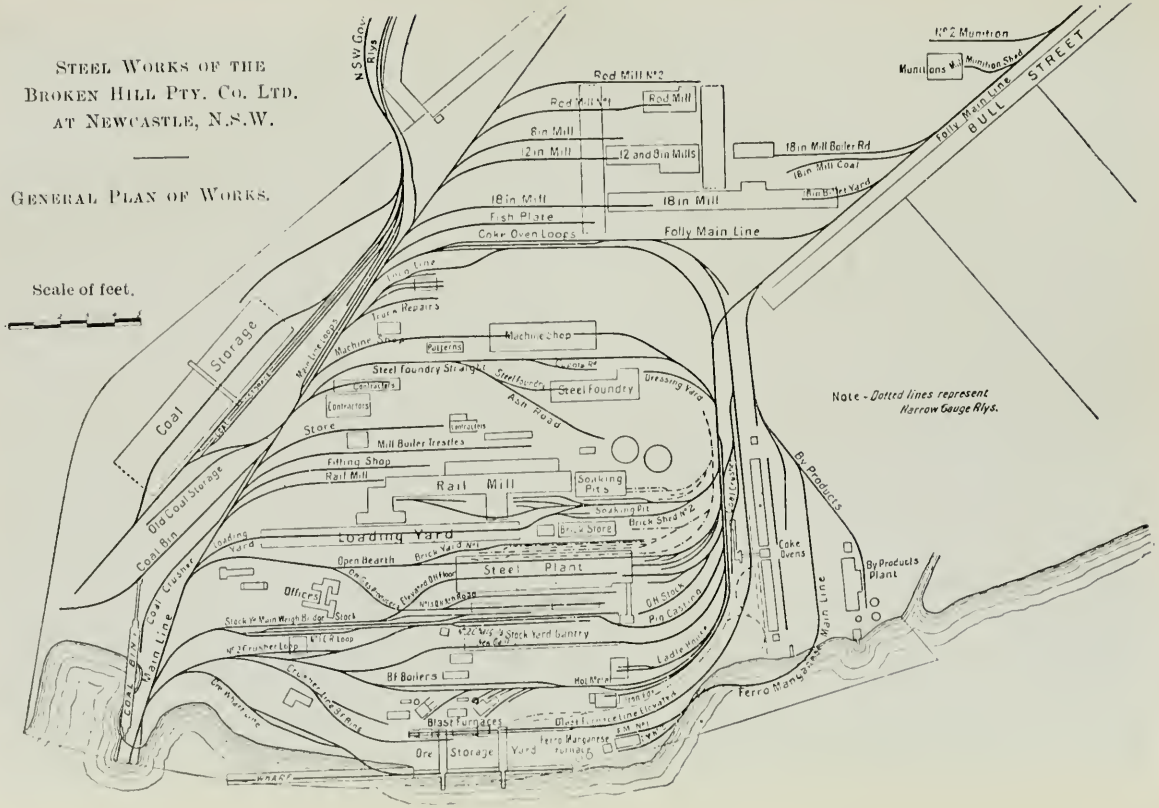
Soaking Pits.—The steel ingots from the open-hearth plant are delivered to the soaking pits, where they are brought to a uniform temperature to enable them to be rolled successfully in the blooming mill.

Blooming Mill.—The blooming mill consists of a 35-in. geared mill, and is driven by a twin-cylinder reversing engine, 42 in. x 60 in. The ingot is rolled in this mill into blooms of a suitable size for the rail mill. Before going to the rolling mill it passes under a shearing machine, which shears the hot blooms into the required lengths for the rolling mill.

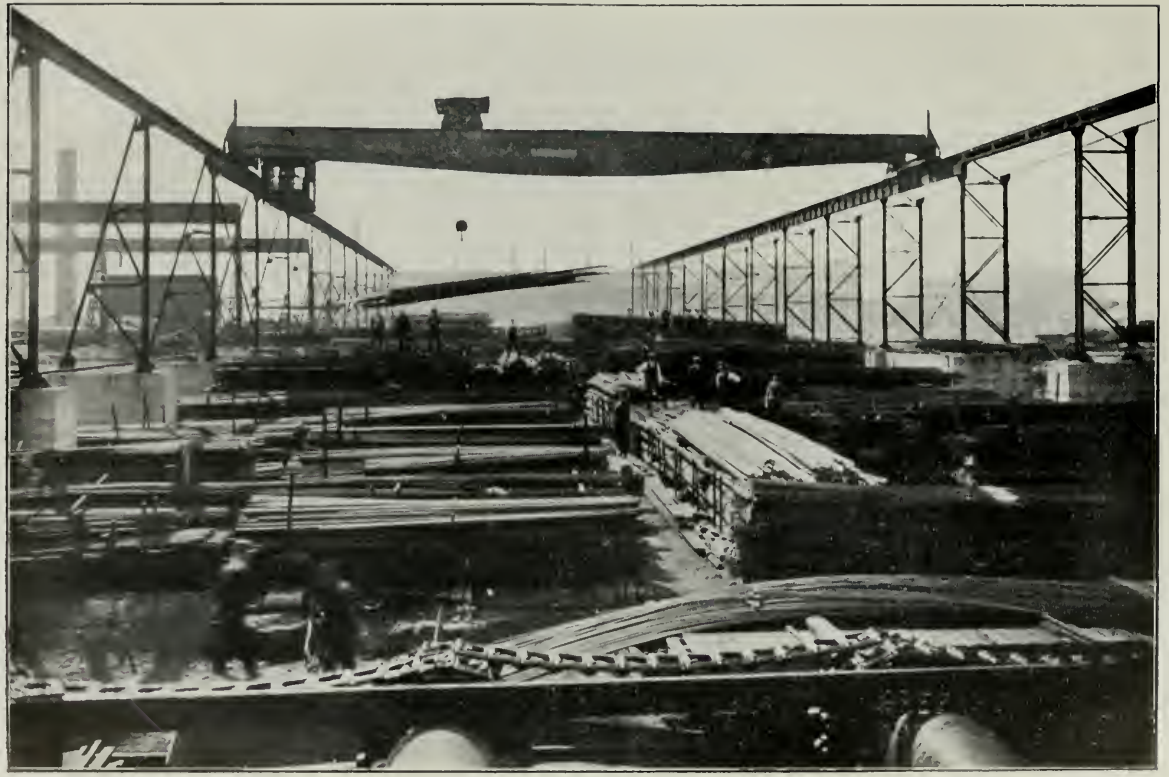
Rolling Mill.—The rolling mill consists of a "three-high" mill, is driven by a similar engine to that which drives the blooming mill, and is worked in the same way with the exception that the engine does not reverse as in the blooming mill.

Steel Works of the Broken Hill Pty. Co. Ltd. at Newcastle, N.S.W.

General Plan of Works.



Open-Hearth Furnaces, Newcastle Steel Works.



Products 18-in., 12-in. and 8-in. Mills, Newcastle Steel Works.

Aberdare Colliery, Cessnock, N.S.W.

The blooms are rolled into the necessary size of the rails required, and the rails, leaving the rolling mill, pass to the circular hot saw, where they are cut into the required lengths. The rail then passes on to the hot bed, where it is allowed to cool, and from there is delivered to the finishing mill, where it is straightened, ended if necessary, and drilled ready for use.

Merchant Mills.—18-in Mill.—The steel required by the 18-in. mill is obtained from the blooming mill. The billets are fed into a gas-fired furnace, re-heated, and thence fed to the mill. The mill is a "three-high" type, continuous-running, and operated with four travelling tables. The finished product consists of light rails, fish-plate bars, light structural material, and billets for the smaller merchant mills.

12-in Mill.—This mill receives its billets from the 18-in. mill, and produces smaller sections of rounds, squares, flats, etc.

8-in. Mill.—This mill produces sizes less than $\frac{1}{2}$-in. rounds for the merchant trade, and is driven by a Bellis–Morcom high-speed engine.

Fishplate Mill.—The fishplate mill receives its bars from the 18-in. mill and shears them into lengths. The bars are then re-heated and fed to a punching machine, where the holes are punched. The bars are then straightened, cooled, and inspected, and, after oiling, are tied into bundles for despatch.

Rod Mill.—This is the latest addition to the works, and it adjoins the 12-in. and 8-in. merchant mills. It consists of a continuous rod mill with sixteen pairs of rolls. A gas-fired furnace re-heats the required billets. The size of the rod at present rolled is No. 5. The rods are coiled in bundles of approximately 300 lb. weight. These rods are now being drawn in Melbourne into the various-sized wire necessary for the Australian market.

Steel and Iron Foundry.—The works have erected an extensive steel foundry, which has been found necessary in order to make the large steel castings required in construction of the new blast furnace and other important works. A 25-ton acid open-hearth furnace has been installed. This furnace is tar-fired, and has been found to be eminently satisfactory.

Coke Ovens.—The coke ovens used are of the Semet–Solvay by-product type. The original plant consisted of 66 ovens, but this has now been increased to 99, and a further 33 are now in hand. The gas from the ovens is passed through condensers to the by-product

house, where tar and ammonia are extracted. The ammonia is converted into sulphate of ammonia for use as fertilizer.

Power Plant.—Energy for the power house and the blooming mill is furnished by five batteries of Babcock and Wilcox boilers of 5155 sq. ft. of heating surface. These boilers supply the necessary power to a 1000 kw. steam turbine set and three 500 kw. generators, the latter being driven by high-speed Bellis-Morcom engines.

General.—The drawing of wire rods in Australia has supplied a long-felt need. In addition to this industry, steps have already been taken to establish works for the manufacture of galvanized iron. The steel made is of the finest quality, and the rails turned out for the Australian Government have been highly commended. At the present time there are about 3000 men employed at the works, a considerable number of these being on construction work.

Up to date, over 250,000 tons of steel products have been rolled and several thousand tons of munition steel have been shipped to Great Britain. The company is now busily engaged in the manufacture of plates and other material for the Commonwealth Government's shipbuilding campaign.

At 8 p.m. members were the guests of the Northern Engineering Institute at a smoke social in St. Philip's Hall. During the early part of the evening Mr. C. A. Süssmilch delivered a lecturette on "The Geological Formation of the Main Coal Basin of New South Wales." Mr. Süssmilch's knowledge of the subject and his exceptional qualities as a lecturer evoked the keenest attention. A musical programmme was also provided, and a very enjoyable evening was spent. Mr. J. B. Henson presided.

Tuesday, 27th August.

A special train, which left Newcastle at 9.5 a.m., conveyed members to the siding in the works of the Sulphide Corporation Ltd., at Cockle Creek. Here they were met by Mr. F. H. Evans, manager, and Mr. H. A. Evans, assistant manager. The party, which numbered about 150, was divided into about fourteen sections, and conducted over the whole of the works by Messrs. F. H. and H. A. Evans, Guy Courtney, J. M'Feeters, E. Strangway-Jones, R. E. Cowles, J. Reid, W. J. Jackson, D. M'Gruer, F. S. Sanderson, E. H. Hughes, H. Shaw, A. Gatley-Lyon, and T. Lawrie.

An illustrated description of the works, prepared by the general manager (Mr. C. F. Courtney) and members of his staff, and printed by the Institute, had, previous to the meeting, been supplied to each visiting member. (This description appears in the current issue of Proceedings.)

An excellent luncheon, served by the Mayfield Girls' Patriotic League and provided by the Sulphide Corporation Ltd., was laid in the huge No. 2 superphosphate shed. Mr. F. H. Evans, manager, presided, and, at the conclusion of the luncheon, proposed the toast of "The King." He apologized for the absence of the general manager, Mr. C. F. Courtney, who, owing to the exigencies of business, was unable to be present, but who had forwarded a telegram extending his good wishes to the members. He expressed pride at presiding over such an important gathering, and was particularly pleased to see so many students present.

Mr. A. S. Kenyon, councillor, on behalf of the Institute, thanked the Sulphide Corporation for the handsome way it had received and treated the visitors. He pointed out that the Institute looked upon it as a duty to assist the students in every way. The Institute had to look to their training in order to maintain its high standard. He referred to the foundation of the Institute 25 years ago at Broken Hill, and was not sure whether the Institute founded Broken Hill or Broken Hill founded the Institute.

Mr. F. H. Evans, in reply, referred to the following facts concerning the Sulphide Corporation operations:—To the end of June, 1918, lead ores had been treated to the value of £10,909,000; zinc concentrates to the value of £8,321,000; purchased ore treated was valued at £6,313,000. The Corporation had paid in taxes £728,000, and in dividends £1,665,000. Wages and stores amounted to £16,837,000. Since July, 1914, the value of purchased ore treated totalled £1,805,500, the amount paid to sellers being £1,335,600.

Mr. James Hebbard congratulated the Mayfield Girls' Patriotic League on their splendid patriotic work, and handed over a bowl of silver coins collected by Mr. S. N. Rodda, amounting to £7 17s. 6d., as a mark of appreciation.

After lunch the inspection of the works was completed, and the visitors returned by special train, leaving Cockle Creek at 4.30 p.m.

From 7.45 p.m. to 8.15 p.m. the business meeting was held at the rooms of the Australasian Society in King Street, Newcastle. Mr. H. Herman occupied the chair.

Apologies were submitted from the President (Mr. J. W. Sutherland), Messrs. G. D. Delprat, C. F. Courtney, F. Danvers Power, H. H. Schlapp, and G. C. Klug for their unavoidable absence.

The Chairman requested Mr. A. S. Kenyon to make a statement on behalf of the executive committee in regard to the proposed amalgamation of engineering bodies.

Mr. A. S. Kenyon said that the Institute had progressed from very small beginnings to a position which is equalled by no other technical society in the southern hemisphere—not merely in regard to the status of its members and the number and quality of its publications, but largely in the complete way in which it had refrained from interference in any matter which may be described as trades unionism, or affecting the pecuniary interests of any individual member. Negotiations had been going on for the incorporation of all the engineering bodies in one institution to control the practice and profession of engineering in Australia. That movement culminated in a conference held in Melbourne last February, at which it was resolved—"That the various engineering bodies of the Commonwealth of Australia shall combine and form an institution to conserve the interests of the engineering profession therein." He (Mr. Kenyon) moved an amendment, which was lost, viz. :—

"That this meeting of delegates recommends that the various engineering bodies and institutes shall combine to form a Federal institution to conserve the interests of the engineering profession therein."

This was to show that the Australasian Institute of Mining Engineers was in favour of some kind of federation, but not necessarily in favour of amalgamation. The Council, at a little

later date, before delegates were appointed to the provisional Council in Sydney, passed this resolution :—

"That the Council of the Australasian Institute of Mining Engineers is desirous of assisting the other engineering associations in every way to become a corporate body in matters Federal; but is opposed to such Institute being composed of individual members, and strongly recommends delegates to endeavour to induce other representatives to agree to a Federal Institute representing the various existing engineering institutes of Australia."

The Institute, as represented by its governing body, had never departed from the attitude that it does not propose to give up its control of the examination of the qualifications of mining men for admission to its ranks. Nor does it propose—at any rate willingly—to give up control of mining matters to a body composed almost wholly of non-mining men. In other matters, he believed, speaking for the Council, that there was every possibility of *rapprochement* among the various societies and bodies. He moved :—

"That this meeting of members of the Institute recommends the Council to obtain by ballot the opinion of the members upon the proposed constitution of the Institution of Engineers of Australia, and at the same time to signify to members its opinion of the proposed amalgamation, in order that they may form a correct judgment when casting their vote."

Mr. Wm. Poole, in seconding the motion, said there was no doubt that there should be a Federal body of some kind. In Sydney there were two bodies of a general character, one in Newcastle, one in Queensland, one in South Australia, one or more in Melbourne, one in Tasmania, and so on, whose interests were more or less local or State. The Australasian Institute of Mining Engineers was not only Australian, but Australasian, and had many members even outside of Australasia.

Mr. Aplin said the Institute stands for all kinds of mining and metallurgy and allied professions, and they should conserve that distinctive character. By amalgamating with engineers not interested in mining they may limit their usefulness. They might federate with them; but they should be strongly opposed to amalgamation.

The Chairman said that the Council had spent a lot of time over this matter, and had a unanimous feeling that some sort of federation or co-operation among the engineering societies of Australia was desirable in the interests of engineering, and in the interests of the public. But the proposed constitution of this new body was such that they would lose absolutely their identity, and also their control of the election of members who were in professions allied with mining interests. He thought they should not take a step that would lead to that end without consideration of the gravest character.

Professor Skeats said that under the proposed scheme the Institute members would become only associate members of the new body, and anyone wishing to become a full member of the amalgamated body must put up for election and must accept the fate of selection or rejection from a council composed of 16, in which the Australasian Institute of Mining Engineers may have a representation of only one or two. That seemed to be a serious defect in the proposal. The Institute, as now constituted, embraced mining engineering, not only in its narrowest sense, but in its widest sense, with metallurgists and geologists and other professions more or less allied to mining enrolled in its ranks. That was a factor which made for strength, for it brought together men of diverse and yet closely-allied professions, that they might add their knowledge to the common stock. That would no longer obtain if they amalgamated. Metallurgists and geologists, and teachers of subjects in mining or geology or metallurgy who were not professed engineers, would have no right of election to the new body. He thought it would be proper to join in a scheme of federation of the different branches of engineering, by which existing societies would preserve their individuality but could speak with a united voice on questions which affected the profession as a whole, but not to join in the proposed scheme of amalgamation.

The Chairman said that copies of the draft constitution would, if possible, be obtained for each member of the Institute, otherwise each would receive a fair précis of it. In the taking of the

ballot the Council would consider whether it would be possible to get the feeling of members on the question of the federation of the institutes.

Mr. Garland asked whether admittance to the proposed Institute would involve examination of every man's qualifications.

The Chairman said that presumably it would.

Mr. Garland asked what would be the basis of the examination.

The Chairman said all-round qualification, the same as they had—status and education.

Mr. Garland thought members could not do better than follow the Executive.

The debate was adjourned until 7.30 p.m. on Thursday evening, 29th inst.

Mr. Wm. Poole, at the Chairman's request, presented an invitation from the New South Wales Board of Trade to the delegates, and more especially those from distant parts, to give evidence at a pending inquiry—first, as to the health of employés in the coal mining industry and the housing of employés in coal-mining areas; second, on miners' phthisis in connection with the occupations of rock-choppers, sewer workers, and metalliferous miners.

The minutes of the Annual Meeting, 1918, were then confirmed.

Mr. Poole then gave an abstract of his paper, "The Manufacture of Cement for Blast-Furnace Slag." A discussion followed.

Mr. A. A. Atkinson read in abstract his paper entitled "The Coal Industry of New South Wales." Discussion on this paper was deferred until Thursday evening, 29th inst.

Mr. H. Herman read a paper on "Intensive Boring on the Wonthaggi Field, Victoria," and presented a paper by Mr. Geo. H. Broome on "An Improved Method of Dumping Spoil." Discussion on these papers was postponed, and the meeting adjourned until Thursday, 29th inst., at 7.30 p.m.

Wednesday, 28th August.

At 8.55 a.m. the party left Newcastle by train for Cessnock to inspect the Aberdare coal mine. Interesting geological notes by Mr. C. A. Süssmilch on the country passed from Newcastle to

Cessnock were distributed at the commencement of the journey. At Cessnock railway station members were received by Mr. D. M'Geachie, superintendent Caledonian Collieries Ltd., and by Mr. J. M'Geachie, mine manager. Arrangements were so well made by the management that the whole of the party, numbering about 130, were taken below to the working level (500 ft.), and after their underground inspection returned to the surface without reducing the daily output of about 2200 tons, hauled to the surface in one shift in less than 7 hours' actual working time. Each section of the party saw the coal-cutters in operation.

The visitors were then entertained at lunch by the Caledonian Collieries Ltd. in a large marquee specially provided for the occasion. Mr. D. M'Geachie presided, and expressed his appreciation of the honour the Institute had done the company in setting aside a day for the visit.

Mr. H. Herman, on behalf of the visitors, thanked Mr. M'Geachie for his warm welcome.

After lunch an inspection was made of the surface plant and equipment, and a return made to Newcastle by the 3.50 p.m. train from Cessnock.

The following is a summary of the main points of interest concerning the mine :—

Aberdare Colliery was sunk to the Greta Measures in 1905, the depth from surface being 500 ft.

The method of working is by pillar and stall.

The shafts are 18 ft. and 15 ft. diam., the former being the "downcast," in which are placed the double-deck cages for drawing coal, and the latter the "upcast," used for the return air to fan, and emergency—that is, the men can be drawn up here if required.

The coal is won by electrical coal-cutters of the Sullivan chain-type, which hole under the seam a distance of 5 to 7 ft. After being cut, the coal is blown down by explosives. The haulages are "endless," the shaft heading being worked by a strap rope running down the "upcast" shaft. The other haulages are worked by separate units, all having electrical motors.

Surface Machinery.—The winding engine is double-horizontal high pressure, 28 in. in diam., 5-ft. stroke, with 14 ft. diam. parallel drum, the cylinders being fitted with piston drop valves and Corliss

exhaust valves, these being actuated by eccentrics, and through a wrist plate secured to the side of the cylinder. The brake is placed in the centre of the drum, air-ventilated, of the Post type, and worked by a steam cylinder and floating levers attached to engine-man's handles.

Boilers.—There are eight Lancashire boilers, 30 ft. long by 8 ft. 3 in. diam., for a working pressure of 150 lb. per sq. in. These are at present hand-fired, and the steam is not superheated.

Power.—The electrical plant is composed of one 750 kw. mixed-flow Curtis impulse turbine, connected to a surface condenser with Edwards three-throw air-pump and centrifugal circulating pump, two 100 kw. sets, and one 200 kw. set. The voltage is generated at 2200 volts, is 50 cycles, 3-phase, and at this pressure is sent down the mine for haulage, pumping, and coal-cutting. All motors for haulage and pumps above 50 h.p. are coupled direct to the 2200 volts, and motors below 50 h.p. are at 450 volts—static transformers being used. For coal-cutting, sub-stations are placed in the different sections of the mine, and rotary converters are used, so that the coal-cutter motors are worked with a pressure of 240 volts direct current.

The turbine takes the steam from the winding engine through a heat accumulator at about 16 lb. absolute, and all other exhaust from fan engine and high-pressure alternators sets passes direct to turbine.

Fan Engine.—The fan is a "Capel" double inlet, 12 ft. 6 in. diam., 8 in. wide, capable of giving 350,000 cub. ft. of air per min. It is driven through ropes by a double horizontal high-pressure engine, 20-in. cylinder, 40-in. stroke, running at 50 r.p.m., the speed of the fan being 200 r.p.m.

Screens.—There are three screens of the jigging type, which deliver to plate picking bands, the length being 60 ft. to 75 ft. The slack, or small, after passing through the screens, falls into conveyers, where it is dragged into a separate bunker, so that it can be loaded direct into waggons, or taken by a series of plate and rubber conveyers into a large storage bin, where it can be taken out and loaded into waggons as required. The screens are all driven by electric motors.

Head Gear.—This is 75 ft. high to centre of pulleys, and of lattice type, the pulleys being 14 ft. 6 in. diam. and weighing about 4 tons.

Decking Plant.—The cages used in the "A" or "downcast" shaft, in which coal is raised, are double deck—that is, they have two

floors, one immediately below the other, each floor or deck carrying two skips in tandem, the weight or tare of each skip being 6 cwt. 2 qr., carrying 22 cwt. of coal.

The loading and unloading of these cages is done simultaneously by hydraulic power as follows :—At each end of main cages are placed cages of similar size to former, with rams underneath them. The cage to receive the empty skips is lifted and two empty skips put in the bottom deck, and the cage is then lowered and two more empties put on top deck. When the main cage is put on "keps" (a hydraulic ram having two pushing poles), the same centres of skip buffers push the empties out of cage, and these in turn push the full skips before them out of the main cage into the waiting full hydraulic cage at the opposite end. Thus, when the operation is complete (which takes from 5 to 7 seconds), the empty skip cage has got rid of its load and the main cage has had full ones replaced with empties, the "fulls" being in the cage which was waiting to receive them and lifted to screen level.

One feature of this latter cage is that the rams are placed slightly out of the centre, so that when the power is applied the end next the main cage is lifted up first, thus making the inclination of floor about 1 in 20, so that the full skips come out of the cage without any help.

Pit Bottom.—The pit bottom is similar to top, with the exception of the fact that the loading with full skip is done from either side, and consequently pushers are provided at both sides.

The pressure for surface arrangements is obtained from a duplex hydraulic pump giving 500 lb. per sq. in., and an accumulator of 30 gal. capacity works in conjunction with it. The pressure for pit bottom is obtained from a column of water in the shaft, which is supplied from a reservoir on the surface, and gives 210 lb. pressure.

In the evening the Institute dinner was held in the Café Patriotic. Mr. H. Herman presided. Prominent citizens at the Chairman's table included Alderman R. G. Kilgour, Mayor of Newcastle ; Mr. Langwill, representing the Chamber of Commerce ; Mr. A. Goninan, representing the Manufacturers' Association ; Mr. Noyes, representing the Broken Hill Pty. Co. and Mr. Pulver, president of the Northern Engineering Institute. The dinner was served by the Mayfield Girls' Patriotic League.

The loyal toast was duly honoured.

The Chairman (Mr. H. Herman) proposed the toast of "The Industries of Newcastle." He said that the previous occasion on which he had presided at the annual dinner, at Scott's Hotel, Melbourne, in 1914, was marked by the presence of a distinguished gathering, including the Victorian vice-regal representative, Sir Arthur Stanley, and a brother engineer and friend of many of the visitors to Newcastle, who was now winning for Australia and for himself honours and a name that would live in history—Lieut.-General Sir John Monash, Commander of the Australian Forces in France. Those who were present at that dinner would have no difficulty in remembering that Colonel Monash—as he then was—replied to the toast of "Engineering" with the ability and thoroughness that had marked every task accepted by him; and those who knew him best had unbounded confidence that the same ability and thoroughness would mark the successful accomplishment of the grave responsibilities now resting on him. The visit to Newcastle was a duty that had been facing the Institute for some time. There was no other place in Australia where there had been initiated in recent years enterprises of such vital importance to the Commonwealth as those established since 1914 at Newcastle. Production at the steel works started at a moment that might have been selected by Providence. He knew little of the many minor industries of Newcastle, but was assured that these would share with the greater industries established by the State at Walsh Island and by the far-seeing Sulphide Corporation and Broken Hill Proprietary Company, the prosperity, founded on the magnificent coal resources of the district, that could hardly fail to accompany the future growth of the baby Birmingham of Australia. He thoroughly endorsed the general principles propounded on the preceding Saturday evening in the address to members by Mr. Goninan in respect to the supply of energy for industrial development of the Newcastle district. The question, however, as to whether there should be long transmission lines was a moot point; it might be as cheap to carry the coal to the power stations as to carry the current to the industries. He (Mr. Herman) referred to the fact that last year the Ministry of

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Munitions and the Board of Trade in Great Britain received reports from the best-qualified men, showing that the future of that country was vitally wrapped up in the question of power supply. It was shown that it would cost £100,000,000 to establish electricity supply on the right basis ; and that if the present conditions were not put right the loss direct and indirect would probably amount to £100,000,000 per annum. Scientific control of electrical energy supply, with proper standards and ordination, were vital. There should be no electrical break of gauge within the States to furnish for the next generation problems to solve comparable with that of inter-State breaks of railway gauge. Everyone would join with him in heartily wishing Newcastle prosperity, for prosperity to Newcastle meant prosperity to the Commonwealth.

Mr. H. C. Langwill, representing the president of the Newcastle Chamber of Commerce, responded, and referred to the fact that a few years ago the response to the toast would have been easy, because there was then practically only one industry in their midst. The fact of the visit of such a body as the Australasian Institute of Mining Engineers showed what the development of industrial life in Newcastle was at the present day. He also emphasized the necessity for co-ordination of effort to meet the heavy burden of national indebtedness that would result from the war.

Mr. A. Goninan proposed the toast of "The Australasian Institute of Mining Engineers." He said that amongst the members were many leading men of Australia—metallurgists, geologists, and practical mining men. He laid great stress on the necessity for the expansion of the secondary industries, and said it was their duty to meet more often, and to compare ideas, with the purpose of competing successfully with the other nations of the world. America last year raised 475 millions of tons of coal and produced 33 million tons of steel, while England had fallen back to six millions of tons. It showed that for a country to be successful it must be able to support its own people with the minimum of expenditure. He spoke of England's great

financial resources and her moneyed relations with the other Powers. He said that they wanted to stop England being merely living on commission; she must take her place in the industrial van of the world's production, and Australia must be a good son to such a worthy parent. He hoped that the Institute would pay another visit to Newcastle at a no distant date.

The Chairman proposed a silent toast to the members of the Institute on active service. He said that about one-fifth of the members had enlisted; already they had to honour the memory of some who would not return. He asked all to drink to the safe return of the Institute's soldier members to the Australian homes they were fighting for. The toast was honoured in silence.

Mr. J. Hebbard responded to the toast of the Institute. He said that the "silent toast" made them think seriously of their duty to their fellows away fighting the nation's battles and their battles. He hoped they would come back to enjoy the blessings of victory they were going to gain for Australia and the civilized world. He spoke in eulogistic terms of the industries Newcastle possessed in the steel works and the Sulphide Corporation's works. He believed that the energies of the men in charge of Newcastle's various industries would build up the place to a position second to none in the southern part of the world.

At the instance of Mr. A. S. Kenyon the health of Mr. C. A. Süssmilch, secretary to the committee in charge of local arrangements, was drunk, and acknowledged by Mr. Süssmilch, who said that an equal share of any credit was due to every member of the local committee.

Before the party dispersed the Chairman expressed the members' appreciation of the excellent dinner prepared by the Mayfield Girls' League, and congratulated the League on its patriotic work. A collection round the table brought £4 8s. to the League, while the sale of a stray fountain pen, sold by the Chairman, who knew so little of the rules of auctioneering that he collected the cash value of every bid, realized an additional sum of £25 for the same purpose.

Songs and instrumental music were rendered during the evening.

Thursday, 29th August.

At 9 a.m. members were conveyed by steamer to Walsh Island, where a visit of inspection was made of the State Government dockyard. The party was conducted over the works by Mr. A. E. Cutler, director of engineering; Mr. A. M. Bomphrey, director of shipbuilding, and other officers connected with the works. The more important features of the works were the pipe foundry, steel casting, boiler-making, a multitude of ingenious tools in the machine shop, the making of a large number of road tractors, rivet and bolt making machines, the punching and trimming of ship-plates, and, lastly, two Isherwood 5000-ton steel ships well on their way to completion.

The return journey to Newcastle was made at 12 o'clock.

During the afternoon the party divided. Some members visited the engineering works of Messrs. Morison and Bearby, at Carrington, and of Messrs. A. Goninan and Co., at Wickham. The remainder of the party took part in the geological excursion to Mereweather, conducted by Mr. C. A. Süssmilch, who explained that the cliffs at Newcastle give a section of the lower part of the Newcastle coal measures.

At 7.30 p.m. the business session was resumed in the rooms of the Australasian Society. Mr. H. Herman presided, and read the motion submitted by Mr. A. S. Kenyon on Tuesday evening *re* the proposed amalgamation of engineering bodies. As there was no further discussion, the motion was put to the meeting and carried unanimously.

Mr. C. A. Süssmilch moved, and Mr. Wm. Poole seconded—

"That it be a recommendation from this meeting to the Council to consider the desirability of altering the name of the Institute to that of the Australasian Institute of Mining and Metallurgy."

Mr. Süssmilch said the section of Metallurgy was becoming more important each year. To-day it was equally important with mining, and that fact ought to be recognized in the title of the Institute.

Mr. Aplin supported the motion.

After a general discussion on the advisability of retaining the term "Engineers," the motion was carried, with two dissenting votes.

An announcement was made that it had been practically decided that the Institute would shift its quarters from the rooms in Swanston Street, Melbourne, to rooms in Queen Street.

Mr. Garland suggested that the Institute take a more active interest in titles to mining properties and help legislation to make property secure. There was a Bill now before Parliament which would make all mining insecure.

The Chairman said the suggestion would be brought before the Council, but mentioned that the Council had always set itself against any interference on the legislative side of mining, because they could see great dangers in it, and considered the Institute would thrive better by restricting itself to the technical side. There were times when the Institute had been embarrassed by members bringing up that sort of thing.

Mr. Kenyon suggested that Mr. Garland bring the matter before the Australian Mines and Metals Association.

Mr. Wm. Poole thought the Institute should take an active interest in the subject of mining regulations which govern the safety of mine-working. Although these were legislative to a certain extent, they were practically professional points.

Discussions were resumed on the following papers :—"The Coal Industry of New South Wales," by A. A. Atkinson, and "Intensive Boring on the Wonthaggi Field, Victoria," by H. Herman.

A paper by Professor E. W. Skeats and E. O. Teale, entitled "A New Phosphate Deposit in the Howqua District, Victoria," was read by Professor Skeats and discussed.

"Some Notes on the Geology of Stannary Hills, North Queensland," by G. B. Hope, was, in the absence of the author, taken as read.

A short paper by Mr. S. R. Mitchell, entitled "An Experimental Electric Furnace," was read by the author and discussed.

The following papers were also formally presented :—"The Human Side of Engineering," by F. Danvers Power, and "Flow of Compressed Air in Pipes," by Johan Sarvaas.

The Chairman reported that these papers, as well as those which had been read, would appear in the Proceedings, when members would be invited to contribute written discussions thereon.

At the suggestion of Mr. Poole, the Chairman said that more time would, if practicable, be set apart at future meetings for discussion of papers.

The meeting, which was one of the most successful in the history of the Institute, then terminated.

MINUTES OF MEETINGS.

OF THE EXECUTIVE COMMITTEE.

(Abstract.)

JULY 8TH, 1918—1 P.M.

The Secretary's report was presented and accounts to the amount of £24 were passed for payment.

A report was submitted regarding the position of Members who had qualified for Commissioned rank in the A.I.F., but who had not received Commissions. Resolved that no further action be taken at present.

A progress report of arrangements in connection with the First Ordinary Meeting, 1918, showed that a good attendance was assured. A local Committee consisting of Messrs. G. D. Delprat, F. H. Evans, D. McGeachie, D. Morrison and C. A. Süssmilch was appointed.

Resolved that the Advisory Council of Science and Industry be requested to arrange for the continuance of Dr. Stillwell's work on the localization of gold shoots.

Other routine business was transacted.

AUGUST 12TH, 1918—1 P.M.

The Secretary's report was presented and accounts to the amount of £83, including £45 advance expenses First Ordinary Meeting, were passed for payment.

A report from the Broken Hill Branch was submitted.

A letter was read from the President (Mr. J. W. Sutherland) expressing regret at his inability to attend the First Ordinary Meeting. Resolved that Mr. H. Herman (Past President) be appointed leader of the meeting.

Consideration was given to the draft of the proposed constitution of the suggested Institute of Engineers of Australia, and to the report thereon by the Institute's representatives on the

Provisional Council. It was resolved that the Constitution as at present drawn up cannot be recommended for acceptance by members.

Applications for admission to the Institute were submitted and dealt with as follows:—John Avery, transfer Associate Member to Member—approved; James Farish Stephens, as Member—approved; George Burrell Game, as Associate Member —approved.

Mr. L. Keith Ward was appointed the Institute's representative on the Mining and Metallurgical Bursaries Committee attached to the Adelaide University.

The proposal to transfer the head office of the Institute to 48 Queen Street, Melbourne, was referred to the Rooms Committee with power to act.

SEPTEMBER 16TH, 1918—1 P.M.

The Secretary's report was presented and accounts to the amount of £90, including printing Proceedings £52, were passed for payment.

It was decided that special letters be forwarded to members whose subscriptions were owing.

Nomination of Mr. L. Keith Ward, as a Member, was approved and consideration of other nominations deferred pending receipt of fuller particulars regarding qualifications.

Resolved that the chairman of the Provisional Council of the proposed Institution of Engineers of Australia be informed that the Australasian Institute of Mining Engineers proposed to submit the question of amalgamation to members for ballot, with a recommendation from the Council to the effect that it did not favor amalgamation but was prepared to consider the formation of a Federal Institute composed of associations but not of individuals.

A report was submitted from the Publication Committee and received.

Resolved that the Annual Meeting be held on January 31, 1919, at 1 p.m.

It was decided that the recommendation of the First Ordinary Meeting, that the name of the Institute be altered to "The Australasian Institute of Mining and Metallurgy," be published in the Proceedings, and that a ballot be taken thereon at the same time as the ballot *re* proposed Amalgamation of Engineering Associations.

A report of the First Ordinary Meeting, held at Newcastle, was submitted and adopted.

Members of the Committee then adjourned to inspect the rooms which it was proposed the Institute should occupy at 48 Queen Street, Melbourne. A Sub-Committee was appointed to report on the matter.

SEPTEMBER 25TH, 1918—1 P.M.

The Rooms Sub-Committee reported in favor of accepting the offer of rooms at 48 Queen Street. The report was adopted and directions given regarding the transfer of the Institute's property to the new rooms.

NOTICES.

The rooms of the Institute are open from 9 A.M. to 5 P.M. daily, except Sundays and Public Holidays.

MEMBERSHIP.

Applications for admission to the Institute have been received from the following :—As Members—James Farish Stephen, Junction North Mine, Broken Hill, N.S.W., and Leonard Keith Ward, Director of Mines and Government Geologist, Adelaide, S.A. Transfer from Associate Member to Member—J. Avery, Electrolytic Zinc Co., Risdon, Tasmania. As Associate Members —George Burrell Game, South Silver Mines, Broken Hill, N.S.W. These names are now submitted to members for confidential report.

LOCATION OF HEAD OFFICE.

Arrangements have been made for transferring the head office of the Institute to rooms at 48 Queen Street, Melbourne. These rooms are in the centre of the mining quarter of the city, and therefore much more suitable for the home of a mining institute than those at present occupied. In its new quarters the Institute will be associated with the Australian Mines and Metals Association.

PUBLICATIONS.

Papers appearing in this issue are :—

PAPERS—Illustrated Description of the various plants in operation at the Cockle Creek Smelting Works (Sulphide Corporation Ltd.), New South Wales.
Manufacture of Cement from Blast-Furnace Slag. By Wm. Poole.
The Coal Industry of New South Wales (with inset table). By A. A. Atkinson.
An Improved Method of Dumping Spoil (with 1 Plate and 1 Fig.). By Geo. H. Broome.
Experimental Electric Furnace (with 1 Fig.). By S. R. Mitchell.
Some Notes on the Geology of Stannary Hills, North Queensland (with 5 Figs.). By G. B. Hope.
Flow of Compressed Air in Pipes. By Johan Sarvaas.
The Human Side of Engineering. By F. Danvers Power.

Written contributions to the discussions on these papers are invited.

The following papers will be included in the December issue :—

PAPERS—Intensive Boring on the Wonthaggi Field, Vic.. By H. Herman.
A New Phosphate Deposit in the Howqua District, Vic. By Professor E. W. Skeats and E. O. Teale.

ANNUAL MEETING, 1919.

The Annual Meeting, 1919, will be held at the rooms, 48 Queen Street, Melbourne, on Friday, 31st January, 1919, at 1 p.m. The business of the meeting will include the presentation of the Annual Report and Balance Sheet for 1918, and the election of officers to fill the annual vacancies. The officers retiring are :— President, Mr. J. W. Sutherland; Vice-President, Mr. W. E. Wainwright; Councillors, Messrs. G. D. Delprat, Geo. H. Broome, Richard Hamilton, A. S. Kenyon, George C. Klug and George Weir. Nominations to fill the vacancies thus occurring should reach the Secretary forty days before the Annual Meeting.

A. T. DANK'S PRIZE, 1918.

A number of papers are to hand from students competing for the "A. T. Dank's Prize, 1918." This prize, the gift of Aaron T. Danks, Esq. of Melbourne, is awarded for the best paper by students taking part in the Institute excursions, which this year was to Newcastle, N.S.W. The result will shortly be announced.

ON ACTIVE SERVICE.

E. H. Fraser (Capt.) who lost an arm at Pozieres in 1916, is now in the A.I.F. Engineers Depot at Brightlingsea, England, training Engineer Companies for the Front.

W. H. Mawdsley, for some years on Active Service in France, has returned to Australia and is now at Rockhampton, Q.

Killed in Action.

Virgil Tucker, who, until he enlisted early in the war, was with the Zinc Corporation Ltd., Broken Hill, was killed in 1916 whilst on Active Service in France.

MOVEMENTS OF MEMBERS.

Malcolm S. Moore, who has been in England on war work since 1915, has returned to Melbourne.

K. Ikeda has, for the last fourteen months, been travelling in Australia and America and is at present in charge of the Kosaka Smelters, Japan.

R. M. Sewell, late of Cloncurry, Q., has been appointed Director of the School of Mines and Industries, Stawell, Vic.

Colin C. Corrie, recently with the Mount Lyell M. and R. Co. at Queenstown, Tas., is now at Silver Spur, Q.

W. B. Chomley is now on the metallurgical staff of the Zinc Corporation Ltd., at Broken Hill. Until recently he held the position of metallurgist on the Great Fingall Mine, Day Dawn, W.A.

John W. Moule has been appointed assistant general manager of the Burma Mines Ltd., Mampwe, Burma. Positions previously occupied by Mr. Moule were that of metallurgist, Great Cobar Ltd.; assistant superintendent, Mount Morgan G. M. Co., and superintendent, Great Fitzroy Mine. He leaves for Burma in November.

OBITUARY.

Osmer B. Ward, for six and a-half years manager of the Broken Hill Proprietary Block 10 Mine, died in Melbourne in July. He has been a Member of the Institute since 1913. He undertook the development of gold mines at Mesima, Papua, and although the disease which resulted in his death was not contracted there, his absence from efficient medical aid contributed somewhat to the final result. Mr. Ward was 42 years of age. He had exceptional ability as a mining engineer and was a man of very fine character.

PROPOSED AMALGAMATION OR FEDERATION OF ENGINEERING BODIES.

A draft of the constitution of the proposed Institution of Engineers of Australia has been received, and, for the guidance of members, the Executive Committee's report thereon is submitted herewith. The subject was reviewed at the First Ordinary Meeting in August last, when members were very emphatic in their disapproval of the whole scheme of amalgamation (see p. xliv.), and suggested some scheme of federation. The question will be remitted to members for ballot when copies of the final revise of the constitution are received.

Executive Committee's Report.

For some years past various abortive negotiations were made between the several engineering bodies in Australia for federation or amalgamation. In the last Annual Report of the Council (Proceedings No. 29, March, 1918), the opinion was expressed that a federation of the institutes appeared preferable to amalgamation. Messrs. Schlapp, Klug, and Kenyon were then appointed delegates to a conference, convened by the Engineering Association of New South Wales, but held in Melbourne in February last. The following bodies were also represented :— Queensland Institute of Engineers, Engineering Association of New South Wales, Sydney University Engineering Society, Northern Engineering Institute of New South Wales, Victorian Institute of Engineers, Institution of Municipal Engineers of Victoria, the South Australian Institute of Engineers, Electrical Association of Australia (N.S.W. and Victorian sections), and the Institution of Local Government Engineers of Australasia. The following motions were carried :—

" 1. That this meeting of delegates recommends that the various engineering bodies of the Commonwealth of Australia shall combine and form an institution to conserve the interests of the engineering profession therein.

" 2. All persons on the rolls of associating societies shall be entitled to enrolment in the institution.

" 3. That a provisional council be elected, to consist of two members from each purely State society and three from each Federal body, and that any association have power to appoint a substitute in the event of the unavoidable absence of its representative.

" 4. That the Council be called together on or before 15th May, 1918, and that its first duty shall be to draft a constitution and submit same to the associating societies for consideration.

" 5. That upon acceptance of the constitution by associating societies the institution shall be deemed to be formed.

" 6. That on transfer to the new institution, all section members of whatever grade under the age of 25 years shall be classified as students and graduates ; all section members of whatever grade over

the age of 25 years shall be classified as associate members. Associate Members over the age of 33 years may apply to the Committee of the Institution for enrolment as full Members."

At the outset it was urged, on behalf of this Institute, that it could not agree to any amalgamation, which would involve the question of qualification for membership of its particular section and that publication of papers should not be done by one body; but it was considered that support would be given to the proposed bringing together of the various sections in every other way.

On the report of this conference being received the same members were elected members of the provisional council, the following resolution of instruction being carried:—

"That the Council of the Australasian Institute of Mining Engineers is desirous of assisting other engineering associations in every way to become a corporate body in matters Federal; but is opposed to such Institute being composed of individual members, and strongly recommends delegates to endeavour to induce other representatives to agree to a Federal Institute representing the various existing engineering institutes of Australia."

Business requirements prevented any one of the delegates appointed attending the meeting in Sydney, in May last, of the provisional council; but, in their stead, Messrs. Wm. Poole and F. Danvers Power were substituted. The result of that meeting is embodied in the proposed Constitution of the Institution of Engineers of Australia. The Executive Committee has carefully considered the proposed Constitution, but regrets to be compelled to express its complete rejection of the main principle involved therein—that is, the associating of individual persons and not of individual institutions. As drafted, the admission of persons to full membership—or to associate membership and lower grades for those joining after formation of the new Institution—is taken out of the control of the sections altogether, applications going direct from the State branches to the State committee, on which our representation would vary from 7 % to 14 %, and from there to the Council, where we might have as little as 8 % representation. The Mining Engineering section, which would replace our present body, would therefore have

no say whatever in the matter of qualification for any grade of membership. It seems also pretty certain that in the "qualifications for members" the expression, "in some branch of engineering," would not be held by the Council, consisting of 90 % of non-mining men, to cover "metallurgist," "metallurgical chemist," "mining geologist," &c. This is a vital question. We are also asked to increase our subscriptions by from 50 % to 150 %, while the proposed Institution anticipates taking half of the total receipts, and as much more as it thinks fit. It is true that body proposes to publish Transactions, comprising technical papers and discussions, though each section and branch has also the right, out of such funds as are left them, to publish. As only a small proportion of mining papers are of interest to members of other sections, it is felt that this proposal is not likely to be of great benefit to our members.

Our Council — and we believe the same is true of members bodily—has all along shown sympathy towards the formation of a Federal Association composed of individual institutions, not of individuals. To this end, its delegates have offered their advice and co-operation; but they regret the organizations now proposing the Constitution of the Institution of Engineers of Australia have not seen eye to eye with them in these matters.

The inclusion of a Mining Section in such new body, and our acceptance of the Constitution, would mean the loss of our identity and of our protection of the scientific and academic interests of mining engineering and metallurgy. It is felt that the present high status achieved by our Institute would not be raised by such an amalgamation. We have all to lose and little to gain.

While thus objecting to the Constitution proposed, we are nevertheless still desirous of co-operating with the other associations in the formation of a Federal Institution, whose province will be to deal with all matters affecting engineers as a body or with any matter referred to it by any associating society.

It is proposed to remit the question whether this Institute shall combine and form itself with other societies into one institution, under the proposed Constitution, to members for ballot under

our rules. Meanwhile, the Council is desirous that members should discuss fully the question at the First Ordinary Meeting, Newcastle, 1918, in order that those not attending may, from perusal of the discussion in the Proceedings, be more fully seized of all the facts.

CHANGE OF NAME.

For some time past the question of changing the name of the Institute to that of "The Australasian Institute of Mining and Metallurgy" has been considered, and at the First Ordinary Meeting, 1918, Newcastle, the following resolution was carried (see p. liv.), viz. :—

"That it be a recommendation from this meeting to the Council to consider the desirability of altering the name of the Institute to that of the Australasian Institute of Mining and Metallurgy."

The Council, in September, resolved that the question be remitted to members to be decided by ballot.

LIST OF PUBLICATIONS ADDED TO THE LIBRARY

From 30th June to 30th September, 1918.

Australian Mining and Engineering Review	monthly	Melbourne
Engineering and Mining Journal	weekly	New York
Iron and Coal Trades Review	weekly	London
Mining and Scientific Press	weekly	San Francisco
The Colliery Engineer	monthly	Scranton, Pa.
Mining and Engineering World	weekly	Chicago
Mining Magazine	monthly	London
Indian Engineering	weekly	Calcutta
Chemical News	weekly	London
South African Engineering	monthly	London
Journal of Industrial and Engineering Chemistry	monthly	Easton, Pa.
Society of Chemical Industry : Journal	bi-monthly	London
Chemical, Metallurgical and Mining Society of South Africa : Journal	monthly	Johannesburg
Franklin Institute : Journal	bi-monthly	Philadelphia
Institution of Mechanical Engineers : Journal	monthly	London
Metallurgical and Chemical Engineering	monthly	New York
Chamber of Mines of Western Australia : Journal	monthly	Kalgoorlie
The West Australian Mining, Building and Engineering Journal	weekly	Perth
Queensland Department of Mines : Government Mining Journal	monthly	Brisbane
Transvaal Chamber of Mines : Monthly Analysis of Production		Johannesburg
Rhodesia Chamber of Mines : Report of Executive	monthly	Bulawayo
Department of Mines, Victoria : Records of Geological Survey, Vol. IV., Part I. Annual Report, 1917		Melbourne
University of Sydney : Calendar for year 1918		Sydney
Department of Mines, Queensland : Annual Report, 1917		Brisbane

New Zealand Journal of Science and Technology :
Journal, Vol., I., Nos. 3 and 4 - - Wellington
New Zealand Institute :
Transactions, Vol. L., 1917 - - Wellington
Board of Science and Art :
Bulletin, No. 1, New Zealand Brown Coals - Wellington
Institution of Chemistry of Great Britain and Ireland :
Proceedings, 1918, Part III. - - London
Institution of Mining Engineers :
Transactions, Vol. LIV., Part 6 - - London
Institution of Mining and Metallurgy :
Bulletins, Nos. 163, 164 and 165 - - London
Società Geologica Italiana :
Bulletin, Vol. XXXVI., Parts 2 and 3 - Rome
Mysore Geological Department :
Reports, Chief Inspector of Mines, 1915-1916 and 1916-1917 - - - - Mysore
Department of Mines, Canada :
Annual Report, Mineral Production, 1917
Summary Report, Geological Survey, 1916
Bulletins, Nos. 22, 23, 24 and 26 - - Ottawa
American Institute of Mining Engineers :
Bulletins, Nos. 138, 139 and 140 - - New York
California State Mining Bureau :
Bulletins, Nos. 74 and 77
Report, No. 3 - - - - California

RECENT ARTICLES ON MINING MATTERS.

(1st July, 1918, to 30th September, 1918).

NOTE.—*This list is prepared for the purpose of placing before members the titles of the more important papers appearing in the usual publications concerned with mining engineering, metallurgy, &c., due regard being had to Australasian requirements.*

LIST OF PUBLICATIONS.

References are given by the number prefixed to each publication in the attached list. Wk., weekly; mth., monthly.

(1) *The Australian Mining Standard*, Melbourne, Victoria, wk., 6d.

(2) *The Queensland Government Mining Journal*, Brisbane, mth., 6d.

(3) *Metallurgical and Chemical Engineering*, New York, mth., 25c.

(4) *The Mining Journal*, London, E.C., wk., 6d.

(5) *Mining and Engineering World*, Chicago, wk., 10c.

(6) *The Engineering and Mining Journal*, New York, wk., 15c.

(7) *The Colliery Engineer*, Scranton, Pa., U.S.A., mth., 20c.

(8) *Mining and Scientific Press*, San Francisco, Cal., wk., 10c.

(9) *Annales des Mines*, Paris, France, mth.

(10) *Publications*, Department of Mines, Melbourne, Victoria.

(11) *Publications*, Department of Mines, Sydney, New South Wales.

(12) *Publications*, Department of Mines, Adelaide, South Australia.

(13) *Publications*, Department of Mines, Brisbane, Queensland.

(14) *Publications*, Department of Mines, Perth, Western Australia.

(15) *Publications*, Department of Mines, Hobart, Tasmania.

(16) *Publications*, Geological Survey, Canada, Ottawa, Ontario.

(17) *Publications*, Bureau of Mines, Toronto, Ontario.

(18) *Publications*, Geological Survey of India, Calcutta.

(19) *Publications*, Geological Survey, U.S.A., Washington.

(20) *Publications*, Geological Survey, Alabama, Montgomery, Ala.

(21) *Publications*, California State Mining Bureau, Sacramento, Cal.

(22) *Reports* Aust. Assoc. Adv. Science, Sydney, New South Wales.

(23) *Transactions and Proceedings*, New Zealand Inst., Wellington, New Zealand.

(24) *Quarterly Journal*, Geological Society, London.

(25) *Transactions*, Inst. Mining and Metallurgy, London, E.C.

(26) *Transactions*, Inst. Min. Eng., London.

(27) *Journal*, Canadian Mining Inst., Ottawa, Ontario.

(28) *Journal*. Chem., Min., and Met. Soc. of S.A., Johannesburg, Transvaal.

(29) *Transactions*, Am. Inst. of Min. Eng., New York City.

(30) *Proceedings*, Colorado Scientific Soc., Denver, Col.

(31) *Journal*, Franklin Inst., Philadelphia, Pa.

(32) *Australian Mining and Engineering Review*, Melbourne, Vic., mth., 6d.

(33) *Transactions*, Am. Soc. C.E., New York City.

(34) *Bulletins*, Société des Ingénieurs Civils, Paris.

(35) *Mining Magazine*, 819 Salisbury House, London, E.C., mth., 1s.

(36) *Publications*, Iron and Steel Institute, London.

(37) *Proceedings*, Inst. of Mech. Eng., London.

(38) *Publications*, Field Columbian Museum, Chicago, U.S.A.

(39) *Journal*, Mining Society of Nova Scotia, Halifax, N.S.

(40) *Transactions*, Mining and Geological Institute of India, Calcutta.

(41) *Publications*, Department of Mines, Wellington, N.Z.

(42) *Journal*, Chamber of Mines of West Australia, Perth.

(43) *Journal of Industrial and Engineering Chemistry*, Easton, Pa.

(44) *Proceedings*, Geologists' Association, London.

LIST OF ARTICLES.

GEOLOGICAL.

The Relation of Sulphides to Water Level in Mexico. P. K. Lucke. (29) Bull. No. 140.
Geology of the Oilfields of North Central Texas. D. Hager. (29) Bull. No. 140.
The Mechanics of Vein Formation. S. Taber. (29) Bull. No. 140.
Pyrite Deposits of Leadville. H. S. Lee. (29) Bull. No. 140.

MECHANICAL.

Length of Service and Care of Hoisting Ropes. (6) June 1, 1918.
Formuke for Hoisting Ropes. (6) June 8, 1918.
Air Lift for Handling Tailings. H. A. Campbell. (6) June 29, 1918.
The Tailing Excavator at the Plant of the New Cornelia Copper Co., Ajo, Ariz. F. Moeller. (29) Bull. No. 140.
Notes on Babbitt and Babbitted Bearings. J. L. Jones. (29) Bull. No. 140.

METALLURGICAL.

The Molecular Physics of Ore Flotation. W. H. Coghill and C. O. Anderson. (3) June 1, 1918.
Critical Elaboration of Quantitative Precipitation Methods. H. Heidenhain. (43) June, 1918.
Smelting Methods at El Paso. Courtenay De Kalb. (8) Serial commenced May 18, 1918.
By-Passing Ore from Stamping Feeders to Tube-Mills. (8) June 8, 1918.
Matte Settlement and Slag Disposal at Grand Forks. W. B. Bishop. (8) June 15, 1918.
A Small Mechanical Sampler. (8) July 15, 1918.
New Fume-Treatment Plant at Anaconda. D. W. Brown. (8) June 29, 1918.
The Groch Flotation Machine. F. O. Groch and W. E. Simpson. (8) July 13, 1918.
Concentrating Carnotite Ore. K. L. Kithil and J. A. Jones. (8) July 13, 1918.
The Cascade Method of Froth Flotation. W. A. Fahrenwald. (8) July 20, 1918.
The Ruth Flotation Machine. A. J. Hosken. (8) July 27, 1918.
The Advent of Modern Mill Mechanism to Nitrate Leaching. D. F. Irvin. (6) June 1, 1918.
Artificial Pebbles for Tube-Milling. A. W. Allen. (6) June 8, 1918.
Iodide Copper Method with Sodium Fluoride. A. L. Reese. (6) June 29, 1918.
Fine Grinding and Porous-Briquetting of Zinc Charges. (6) June 29, 1918.
Treatment of Flotation Concentrates. A. Del Mar. (6) June 29, 1918.
Formulas for Ore Sorting. G. Luna. (6) June 29, 1918.
Belt Concentrators and Wet Concentration. A. M'Laren. (6) July 6, 1918.
Middlings. (6) July 6, 1918.
Grinding of Ore in Ball Mills. A. Del Mar. (6) July 6, 1918.
Determination of Tin in Concentrates. A. M. Smoot. (6) July 6, 1918.
Determination of Tungsten. (6) July 6, 1918.
Data on Crushing and Grinding in a West African Mill. P. T. Bruhl. (6) July 13, 1918.
The Maintenance of High Ampere Efficiency in Electrolytic Copper Refining. M. H. Merriss and M. A. Mosher. (6) July 20, 1918.
Mechanical Scotch-Hearth Smelting. W. E. Newham. (6) July 20, 1918.
Experiments in Fettling Reverberatory Furnaces. F. Rutherford. (6) July 20, 1918.
Ideal Lay-out for Silver-Lead Refinery. Guy C. Riddell. (6) July 20, 1918.
Blast Furnace Plant for Smelting Copper Ore. F. Rutherford. (6) July 20, 1918.
Baghouses for Zinc Oxide. J. F. Cregan. (6) July 20, 1918.
Improvements at the Consolidated Arizona Smelting Co.'s Plant. F. R. Corwin. (6) July 20, 1918.
Notes on Recent Metallurgical Progress. E. P. Mathewson. (6) July 20, 1918.
Wastage of Coke By-Products. F. MacCoy. (6) Aug. 10, 1918.
The Moore–Edwards Process of Precipitating Gold with Charcoal. A. W. Allen. (6) Aug. 10, 1918.
Recovery and Losses of Tin at Giew Mill. (25) Bull. No. 164.
Giew Mill Test. S. J. Truscott. (25) Bull. No. 164.

The Uses of Cinchonine in the Assay of Tungsten Minerals. H. W. Hutchin. (25) Bull. No. 164.
The Metallurgy of Tungsten. Z. Jeffries. (29) Bull. No. 138.
The Elko Prince Mine and Mill. J. V. N. Dorr and L. D. Dougan. (29) Bull. No. 140.
Crushing Resistance of Various Ores. L. W. Lennox. (29) Bull. No. 140.
Roasting for Amalgamating and Cyaniding Cripple Creek Sulpho-Telluride Ores. A. L. Blomfield and M. J. Trott. (29) Bull. No. 140.
Effect of Oxygen upon the Precipitation of Metals from Cyanide Solutions. T. B. Crowe. (29) Bull. No. 140.
Fine-Grinding Cyanide Plant of Barnes-King Development Co. J. H. M'Cormick. (29) Bull. No. 140.
The Manufacture of Ferro-Alloys in the Electric Furnace. R. M. Keeney. (29) Bull. No. 140.
The Condensation of Zinc from its Vapour. C. H. Fulton. (29) Bull. No. 140.

MINING.

Hoisting by Stages from Deep Mines. R. A. Balzari. (8) July 13, 1918.
Mining on the Rand. H. F. Marriott. (8) July 20, 1918.
Drift-Gravel Mining in Eastern Siberia. J. P. Hutchins. (6) May 11, 1918.
Mining Lower Levels of the Comstock Lode. L. H. Eddy. (6) June 8, 1918.
Recovering Caved Stopes in Narrow Veins. C. T. Rice. (6) Serial commenced June 15, 1918.
Fireproofing Mine Shaft of the Anaconda Copper Mining Co. E. M. Norris. (6) June 22, 1918.
Notes on Shaft Re-lining with Concrete. G. G. Stonemark. (6) July 6, 1918.

MISCELLANEOUS.

Some Results of Analysis of Airs from a Mine Fire. A. G. Blakeley and H. H. Geist. (43) July, 1918.
Formulas for Mine Valuation. W. W. Whitton. (8) May 18, 1918.
A Professional Blunder. (8) June 8, 1918.
The Human Side of Engineering. J. F. Kemp. (8) June 15, 1918.
The Basic Principle of Concrete Mixers. D. A. Abrams. (8) July 6, 1918.
Gold is Essential. W. J. Loring. (8) July 20, 1918.
The Menace to Gold Mining. (8) July 22, 1918.
The Gold Industry and Gold Standard. H. Jennings. (6) May 11, 1918.
Cost of Australian Copper. R. Slessor. (6) June 15, 1918.
Electric Power for Mining in Yavapai County, Arizona. (6) June 22, 1918.
Iron Ore Report of Advisory Council, Department of Scientific and Industrial Research. (6) June 22, 1918.
The Mining Districts of Joplin and South-East Missouri. H. W. Kitson. (6) Serial commenced Dec. 22, 1917.
The Mineral Industry of Portugal. F. W. Foote and R. S. Ransom. (6) July 13, 1918.
The Survey Office on the Rand. E. M. Weston. (6) July 13, 1918.
Mill Jig Tests for Tin Dredging. L. H. Eddy. (6) July 13, 1918.
Use of Pulverized Coal at the Bunker Hill and Sullivan Smelting and Refining Plant. C. T. Rice. (6) July 13, 1918.
Safety Appliances in Smelters and Refineries. G. M. Douglass. (6) July 22, 1918.
Dust Prevention in Transvaal Mines. (6) Aug. 10, 1918.
Engineering Problems Encountered During Recent Mine Fire at Utah-Apex Mine, Bingham Canyon, Utah. V. S. Rood and J. A. Norden. (29) Bull. No. 138.
Radium. R. B. Moore. (29) Bull. No. 140.
Electrostatic Precipitation. O. H. Escholz. (29) Bull. No. 140.

GUIDE TO CONTRIBUTORS OF PAPERS.

It is requested that writing be confined to *one* side of the paper ; that it be legible with particular care regarding foreign words; and that abbreviations, references, &c . be made in accordance with the subjoined rules and examples:—

Pounds, shillings, and pence, £ s. d. ; dollars and cents, $, c.
Grains, gr., pennyweights, dwt. ; ounces, oz. ; drachms, dr. ; pounds, lb.
Quarters, qr. ; hundredweights, cwt.: gallons, gal.
Grammes, grm. : kilogrammes, kg. ; millimetres, mm.: milligrammes, mg.
Centimetres, cm. ; cubic centimetres, cc.: metres, m.
Inches, in. ; feet, ft.: yards, yd.: fathoms, fath.
Square inches, etc , sq. in. ; cubic inches, etc., cub. in.
Diameter, diam.: revolutions, rev.; revolutions per minute, r.p.m.
Horse power, h p.; indicated horse power, i.h.p.; brake horse power, b.h.p.
Candle power, c.p.
British thermal units, B.Th.U.
High pressure, H.P. : low pressure, L.P.
Ampere, amp.: kilowatts, kw.
Percentages. %; degrees, °; specific gravity, sp. gr.
Company Limited, Co. Ltd.; and Company, & Co.
Temperatures to be given in Fahrenheit, thus : 10° Fahr.

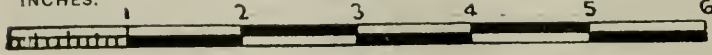
Figures not exceeding four, unless in column with others exceeding four, to be without comma, thus : 1907.

References to be placed in foot-notes, giving title in italics, thus : *Alfred James. *Cyanide Practice*, p. 94 : † H. Brown. *Mines and Minerals*, vol. xiii., p. 130: ‡ *Trans. Aust. Inst. M.E.*, vol. x, pp. 98-189.

Quotations to be indicated by inverted commas, and when lengthy, to be set in smaller type, with inverted commas at beginning and end only. Foreign terms to be in italic.

Localisms to be in inverted commas with their ordinary technical definition in parenthesis.

Drawings (on tracing cloth if possible), photographs (unmounted glossy-surface bromides) or other glossy-surface prints, &c., both for exhibition and for publication, are most desirable with almost every communication, and should always be on separate paper from the MS. Blue-prints only to be forwarded when original plans or tracings are **not** procurable. When reference letters are used in drawings for purposes of description, they are best thus : *a b c*, etc. Lettering and figuring on drawings should be **large** to allow of reduction to page size whenever possible. All lines should be black and firm. Each drawing should be accompanied by scale thus :—



N.B.—When in doubt about any point, it would be advisable to communicate with the Secretary.

PROCEEDINGS

OF THE

AUSTRALASIAN

Institute of Mining Engineers.

NEW SERIES.

No. 32.

EDITED BY THE SECRETARY.

This Institute is not responsible, as a body, for the facts and opinions advanced in any of its publications.

31st DECEMBER, 1918.

PUBLISHED QUARTERLY BY THE AUSTRALASIAN INSTITUTE OF MINING ENGINEERS, MELBOURNE.

Australasian Institute of Mining Engineers.

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Broken Hill	J. M. Bridge, c/o Zinc Corporation Ltd., Broken Hill, N.S.W.
Mount Morgan	B. G. Patterson, Mount Morgan, Q.

The Executive Committee consists of all Members of the Council residing, or for the time being, in Melbourne.

Head Office:

48 Queen Street, Melbourne, Victoria.

Institute Matters.

CONTENTS.

	Page
MINUTES OF MEETINGS—	
Of the Executive Committee	lxxiii
NOTICES	lxxvi
PUBLICATIONS—Added to Library	lxxx
RECENT ARTICLES—On Mining Matters	lxxxii

MINUTES OF MEETINGS.

OF THE EXECUTIVE COMMITTEE.

(Abstract.)

OCTOBER 21ST, 1918—1 P.M. (Special Meeting).

Resolved that Messrs. F. Danvers Power and Wm. Poole be informed that, in view of the feeling expressed at the Newcastle meeting, and also by Members of Council, it is not considered desirable for the Institute to be further represented on the Executive Committee of the proposed Institution of Engineers of Australia.

NOVEMBER 11TH, 1918—1 P.M.

The Secretary's report was presented, and accounts to the amount of £66 passed for payment.

Applications for admission to the Institute as members were received from Messrs. Archibald C. Julius and Harold Beach, and were approved.

The resignation of Mr. C. M. Hallett was accepted with regret.

NOTICES.

The rooms of the Institute are open from 9 A.M. to 5 P.M. daily, except Sundays and Public Holidays.

MEMBERSHIP.

Applications for admission to the Institute have been received from the following :—As Members—Harold Beach, Sons of Gwalia Gold Mine, Gwalia, W.A. : Archibald C. Julius, C.S.A. Mine, Cobar, N.S.W. ; and Alexander M'Intosh Reid, Geological Survey Office, Launceston, Tas. As Associate Members—William Hart, Mount Lyell M. and R. Co., Queenstown, Tas. ; Thomas Henry Hooper, Butler's Tin Mine, Torrington, N.S.W. and Leslie Gordon Klem, Noumea, New Caledonia. These names are now submitted to members for confidential report.

Since the last issue of Proceedings the following have been admitted to the Institute .—

MEMBERS.

Names and Addresses.

Avery, John, Electrolytic Zinc Co., Risdon, Tasmania (transferred from Associate Member).

Stephen, James Farish, Junction North Broken Hill Mine, Broken Hill, N.S.W.

Ward, Leonard Keith, Director of Mines, Adelaide, S.A.

ASSOCIATE MEMBER.

Game, George Burrell, Broken Hill South Ltd., Broken Hill, N.S.W.

MOVEMENTS OF MEMBERS.

T. H. Palmer has commenced practice as a consulting mining engineer. His office is at Collins House, Melbourne. Until recently he was general manager of the Junction North mine at Broken Hill.

J. Bowie Wilson has, since the outbreak of the war in 1914, been constantly engaged on the staff of the Second Military District, Sydney. He is a member of the N.S.W. Bar, and intends to resume practice when peace is declared.

Arthur Jarman, recently works chemist to Wilson's Portland Cement Co., Whangarei, N.Z., is now at "Gosford," Mount St. John's-avenue, Auckland, N.Z. He was Professor of Mining Engineering at Auckland University College from 1906 to 1911, and from 1911 to 1916 assistant superintendent of the Waihi Grand Junction G.M. Co.

David Meredith, late manager of the Amalgamated Zinc (De Bavay's) Ltd., at Broken Hill, is now assistant general manager of the Electrolytic Zinc Co., Risdon, Tas.

A. D. Greenlees has been appointed manager of the Amalgamated Zinc (De Bavay's) Ltd., at Broken Hill.

Colin P. Flockart, who has been for some time with the Ooergum G.M. Co., Oorgaum, Mysore State, S. India, returned to Melbourne in December.

Lindsay C. Clark, general manager, Briseis Tin and General Mining Co., Derby, Tasmania, has recently, under commission by the Victorian Government, reported on the best method of opening up the Morwell Brown Coal deposits. Vic.

Captain Walter J. Rose, M.C., who, prior to his enlistment early in the war, was metallurgist for the Amalgamated Zinc (De Bavay's) Ltd., Broken Hill, is visiting America for the Electrolytic Zinc Co.

ON ACTIVE SERVICE.

G. Escott Gabriel (Lieut.), M.M., who has been on active service since the outbreak of the war, returned to Melbourne, *via* America, in December.

H. Hardy Smith, of Korea, and formerly of Narrandera, N.S.W., enlisted in 1918 and reached England in November.

A. H. Kelly (Cpl.) reported on 13th November that he was with the 3rd Light Horse Regiment, 1st Light Horse Brigade, in Palestine.

Killed in Action.

Willoughby G. Bell (Life Member) has been reported killed whilst on active service in 1918. He was formerly manager of the Crœsus South G.M. Co., Kalgoorlie, W.A., and enlisted early in the war.

Appreciation of Services.

Members will read with pride and appreciation the Special Order issued by the Commander-in-Chief of the British Forces (Sir Douglas Haig) in December. The compliment applies very specially to this Institute, 20 per cent. of its members having enlisted. The Order was as follows :—

"A large number of men are now being withdrawn from tunnelling companies for urgent work at home. Before they leave the country I wish to convey to the controllers of mines and to all ranks of tunnelling companies, both Imperial and overseas, my very keen appreciation of the fine work that has been done by the tunnelling companies throughout the last four years.

"At their own special work—mine warfare—they have demonstrated their complete superiority over the Germans, and whether in the patient defensive mining, in the magnificent success at Messines, or in the preparation for the offensives of the Somme, Arras, and Ypres, they have shown the highest qualities both as military engineers and as fighting troops.

"Their work in the very dangerous task of removing enemy traps and delay-action charges, on subways, dug-outs, bridging roads, and a variety of other services on which they have been engaged, has been on a level with their work in the mines.

"They have earned the thanks of the whole army for their contribution to the defeat of the enemy. Their fighting spirit and technical efficiency has enhanced the reputation of the whole Corps of Royal Engineers and of the Engineers of the Overseas Forces.

"I should like to include in the appreciation the work done by the Army Mine Schools and by the Australian Electrical and Mechanical Mining and Boring Company."

ENGINEERING STANDARDIZATION.

At the invitation of the Executive Committee of the Advisory Council of Science and Industry, the Institute was represented at a conference held in Melbourne on 12th December to consider the question of the establishment of a local committee in Australia, to be in direct communication with the British Committee in London, and to act in an advisory capacity to it and draw up standard specifications for the Commonwealth.

PROPOSED AMALGAMATION OR FEDERATION OF ENGINEERING BODIES.

As no provision for "federation" was contained in the draft constitution of the proposed Institution of Engineers of Australia, the Australasian Institute of Mining Engineers' representation on the drafting committee was withdrawn. The Institute is, however, still represented on the provisional council.

PAPERS.

Papers appearing in this issue are :—

"A New Phosphate Deposit in the Howqua District, near Mansfield, Victoria," by Professor E. W. Skeats and Dr. E. O. Teale.

"Intensive Boring on the Wonthaggi Coal-field," by H. Herman.

"Notes on the Blair Athol (Queensland) Coal-field," by J. F. Hall.

LIST OF PUBLICATIONS ADDED TO THE LIBRARY

From 30th September to 31st December, 1918.

Australian Mining and Engineering Review	monthly	Melbourne
Engineering and Mining Journal	weekly	New York
Iron and Coal Trades Review	weekly	London
The Colliery Engineer	monthly	Scranton, Pa.
Mining and Engineering World	weekly	Chicago
Mining Magazine	monthly	London
Indian Engineering	weekly	Calcutta
Chemical News	weekly	London
South African Engineering	monthly	London
Journal of Industrial and Engineering Chemistry	monthly	Easton, Pa.
Society of Chemical Industry: Journal	bi-monthly	London
Chemical, Metallurgical and Mining Society of South Africa: Journal	monthly	Johannesburg
Franklin Institute: Journal	bi-monthly	Philadelphia
Institution of Mechanical Engineers: Journal	monthly	London
Metallurgical and Chemical Engineering	monthly	New York
Chamber of Mines of Western Australia: Journal	monthly	Kalgoorlie
The West Australian Mining, Building and Engineering Journal	weekly	Perth
Queensland Department of Mines: Government Mining Journal	monthly	Brisbane
Transvaal Chamber of Mines: Monthly Analysis of Production		Johannesburg
Rhodesia Chamber of Mines: Report of Executive	monthly	Bulawayo
Department of Mines, New South Wales: Annual Report, 1917		Sydney
Department of Mines, Western Australia: Annual Report, 1917		Perth
Department of Mines, New Zealand: Mines Statement, 1917		Wellington
Geological Society: Quarterly Journal, No. 290		London

Institution of Mining and Metallurgy :
Bulletins, Nos. 166 and 167 - - London
Institution of Mining Engineers :
Transactions, Vol. LV., Parts 3 and 4 - London
North of England Institute of Mining and Mechanical Engineers : Annual Report of Council and List of Members, 1918-19 - - - Newcastle-on-Tyne
Department of Mines and Geology, Mysore State :
Records, Vol. XVI, 1917, Part 1. - - Bangalore
Mining and Geological Institute of India :
Transactions, Vol. XIII, Part 1. - - Calcutta
Department of Mines, Canada :
Mines Branch—Summary Report, 1917
Annual Report of Mineral Production, 1916
Bulletin, No. 20
Report on Building and Ornamental Stones, Vol. V.
Report on the Clay Resources of Southern Saskatchewan
Geological Survey—Summary Report, 1917, Parts B and D
Memoirs, Nos. 82, 95, 103
Museum Bulletin, Nos. 27, 28 Ottawa
American Institute of Mining Engineers :
Bulletins, Nos. 141 and 142 - - New York
Instituto Geologico De Mexico :
Bulletin, No. 36 - - - Mexico
Department of Mines :
Bulletins, Vol. V., Nos. 5 and 6 - - Mexico

RECENT ARTICLES ON MINING MATTERS.

(30th September, 1918, to 31st December, 1918).

NOTE.—*This list is prepared for the purpose of placing before members the titles of the more important papers appearing in the usual publications concerned with mining engineering, metallurgy, &c., due regard being had to Australasian requirements.*

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References are given by the number prefixed to each publication in the attached list. Wk., weekly; mth., monthly.

(1) *The Australian Mining Standard*, Melbourne, Victoria, wk., 6d.

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(6) *The Engineering and Mining Journal*, New York, wk., 15c.

(7) *The Colliery Engineer*, Scranton, Pa., U.S.A., mth., 20c.

(8) *Mining and Scientific Press*, San Francisco, Cal., wk., 10c.

(9) *Annales des Mines*, Paris, France, mth.

(10) *Publications*, Department of Mines, Melbourne, Victoria.

(11) *Publications*, Department of Mines, Sydney, New South Wales.

(12) *Publications*, Department of Mines, Adelaide, South Australia.

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(14) *Publications*, Department of Mines, Perth, Western Australia.

(15) *Publications*, Department of Mines, Hobart, Tasmania.

(16) *Publications*, Geological Survey, Canada, Ottawa, Ontario.

(17) *Publications*, Bureau of Mines, Toronto, Ontario.

(18) *Publications*, Geological Survey of India, Calcutta.

(19) *Publications*, Geological Survey, U.S.A., Washington.

(20) *Publications*, Geological Survey, Alabama, Montgomery, Ala.

(21) *Publications*, California State Mining Bureau, Sacramento, Cal.

(22) *Reports* Aust. Assoc. Adv. Science, Sydney, New South Wales.

(23) *Transactions and Proceedings*, New Zealand Inst., Wellington, New Zealand

(24) *Quarterly Journal*, Geological Society, London.

(25) *Transactions*, Inst. Mining and Metallurgy, London, E.C.

(26) *Transactions*, Inst. Min. Eng., London.

(27) *Journal*, Canadian Mining Inst., Ottawa, Ontario.

(28) *Journal*, Chem., Min., and Met. Soc. of S.A., Johannesburg, Transvaal.

(29) *Transactions*, Am. Inst. of Min. Eng., New York City.

(30) *Proceedings*, Colorado Scientific Soc., Denver, Col.

(31) *Journal*, Franklin Inst., Philadelphia, Pa.

(32) *Australian Mining and Engineering Review*, Melbourne, Vic., mth., 6d.

(33) *Transactions*, Am. Soc. C.E., New York City.

(34) *Bulletins*, Société des Ingénieurs Civils, Paris.

(35) *Mining Magazine*, 819 Salisbury House, London, E.C., mth., 1s.

(36) *Publications*, Iron and Steel Institute, London.

(37) *Proceedings*, Inst. of Mech. Eng., London.

(38) *Publications*, Field Columbian Museum, Chicago, U.S.A.

(39) *Journal*, Mining Society of Nova Scotia, Halifax, N.S.

(40) *Transactions*, Mining and Geological Institute of India, Calcutta.

(41) *Publications*, Department of Mines, Wellington, N.Z.

(42) *Journal*, Chamber of Mines of West Australia, Perth.

(43) *Journal of Industrial and Engineering Chemistry*, Easton, Pa.

(44) *Proceedings*, Geologists' Association, London.

LIST OF ARTICLES.

MECHANICAL.

Efficiency Tests of Rock-Drill Accessory Equipment. C. F. Willis. (6) Aug. 17, 1918.
Automatic Elevator-Bucket Discharge. H. M. Schleicher. (6) Sept. 14, 1918.
Ore Car Designed at Hecla Mine. C. T. Rice. (6) Sept. 21, 1918.
Coal Economy in Mine Boiler Firing. (6) Sept. 21, 1918.
Reverberatory Fore-Hearths. L. Duncan. (6) Sept. 21, 1918.
Conveyor Pulley Guards. G. M. Douglas. (6) Sept. 21, 1918.

METALLURGICAL.

e New American Spirlet Roaster. F. J. Harlow. (6) Aug. 17, 1918.
inding of Ore in Ball Mills. (6) Aug. 17, 1918.
e Comparative Efficiency of Ball Mills. (6) Aug. 17, 1918.
e Treatment in Colorado. (6) Aug. 31, 1918.
asting of Sulphotelluride Ores for Amalgamating and Cyaniding. A. L. Blowfield and J. M. Trott. (6) Aug. 31, 1918.
ie Manufacture of Ferro-Alloys in Colorado. R. M. Keeney. (6) Aug. 31, 1918.
tallurgical Treatment of Radium Ores. R. B. Moore. (6) Aug. 31, 1918.
e Crowe System of De-aerating Cyanide Solutions. T. B. Crowe. (6) Aug. 31, 1918.
e Blast-Furnace Charge at the Bunker Hill Smeltery. C. T. Rice. (6) Sept. 7, 1918.
covery of Selenium and Tellurium in Copper Refining. M. H. Merriss and H. T. Binder. (6) Sept. 7, 1918.
inding Ore in Ball Mills. F. E. Marcy. (6) Sept. 7, 1918.
fferential Flotation at Wallace, Idaho. C. T. Rice. (6) Sept. 14, 1918.
ie "Little" Janey Flotation Machine. (6) Sept. 14, 1918.
nes–Belmont Flotation Machine. (6) Sept 14, 1918.
echanical Screening of Wet Pulp. H. E. Megraw. (6) Sept. 21, 1918.
fferential Flotation of Lead-Zinc Tailing at a Small Plant. (6) Sept. 21, 1918.
iple Concentration Practice for Tin–Wolfram–Lead Ore. (6) Sept. 21, 1918.
malgamation as a Preliminary to Cyaniding. (6) Sept. 21, 1918.
ie Use of Powdered Coal. W. G. Wilcox. (8) June 22, 1918.
ible of Sulphidizing Solutions. K. B. Thomas. (8) June 22, 1918.
and-Sorting of Mill Feed. R. S. Handy. (8) June 22, 1918.
ie Rating of Concentration Tests. R. T. Hancock. (35) Sept., 1918.
ntering and Charge Delivery at the Bunker Hill Plant. C. T. Rice. (6) Oct. 12, 1918.
ew Merton Furnace for Blende. (6) Sept. 28, 1918.
pid Estimation of Cadmium in Spelter. H. Isaacs. (6) Sept. 28, 1918.
etermination of Tungstic Acid in Wolframite. (6) Sept. 28, 1918.
The Distinction Between Extraction and Recovery. A. W. Allen. (6) Oct. 26, 1918.
Smelting and Lead Refining at the Bunker Hill Plant. C. T. Rice. (6) Oct. 26, 1918.
Recording Experimental Flotation Tests. A. F. Taggart. (6) Oct. 26, 1918.
The Action of Reducing Gases on Hot Solid Copper. N. B. Pilling. (29) Bull. No. 142.
The Spectroscopic Determination of Lead in Copper. C. W. Hill and G. P. Luckey. (29) Bull. No. 142.
Lead Refining at the Bunker Hill Plant. C. T. Rice. (6) Nov. 2, 1918.

MINING.

A New Timber Set for Inclined Shafts. J. E. Harding. (6) Sept. 7, 1918.
Method of Mining Pillars at the Fortuna Mine of the Braden Copper Co., Chile. C. Hollister. (6) Sept. 14, 1918.

MISCELLANEOUS.

Yuba No. 17 All-Steel Dredge. L. H. Eddy. (6) Aug. 17, 1918.
The Use of Pulverized Coal.
Development of the Coke Industry in Colorado, Utah, and New Mexico.
The Cloncurry Copper District of Queensland. W. H. Corbould. (6) Sept. 7, 1918.
Effects of Mine-Dust Inhalation. J. S. Haldane. (6) Sept. 14, 1918.
Safety and Health in Hydrometallurgical Plants. A. W. Allen. (6) Sept. 14, 1918.
Handling and Storing of Explosives. A. La Motte. (6) Sept. 14, 1918.
Method of Fixing Prices of Bituminous Coal Adopted by the United States Fuel Administration. C. Garnsey, R. V. Norris, and J. H. Allport. (27) Bull. No. 141.
The Manufacture of Silica Brick. H. Le Chatelier and B. Bogitch. (27) Bull. No. 141.
The Magnetic Needle in Mine Surveying. L. H. Cooke. (35) Sept., 1918.
The Morale of Mill Crews. P. T. Bruhl. (6) Oct. 12, 1918.
Determination of Nitrates in Caliche and its Products. J. E. Clennell. (6) Oct. 12, 1918.
Lead Acetate in Cyaniding. T. B. Stevens. (6) Oct. 12, 1918.
The Effects of Dust Inhalation. J. S. Haldane. (28) July, 1918. Discussion: Sept. and Oct., 1918.
Notes on Electric Furnace Problems. J. L. M'K. Yardley. (29) Bull. No. 142.
Dust Abatement in Mines. W. O. Borcherdt. (6) Nov. 2, 1918.
The Evolution of Ore Deposits from Igneous Magmas. W. H. Goodchild. (35) Sept., 1918.

Papers and Discussions.

CONTENTS.

PAPERS—

Page

Illustrated Description of the various plants in operation at the Cockle Creek Smelting Works (Sulphide Corporation Ltd.), New South Wales—

I. Introductory (with 1 Plate). By C. F. Courtney (General Manager) 1

II. Short Description of the Method of Discharging and Sampling Ore Received (with 1 Plate). By Thomas Lawrie - - 4

III. A Brief Description of the New Assay Office (with 1 Plate). By E. Strangway-Jones - - - - - - 7

IV. Description of the Roasting of Sulphide Ore by the Huntington-Heberlein Process (with 3 Plates). By W. J. Jackson - - 9

V. Description of the Sulphuric Acid, Nitric Acid and Superphosphate Plants (with 6 Plates). By J. H. McFeeters - 13

VI. A Brief Résumé of the Smelting Plant (with 3 Plates). By Guy Courtney - - - - - - - - 21

VII. Description of Lead Refinery (with 6 Plates and 2 Figs.). By R. E. Cowles - - - - - - - - 25

VIII. Description of the Mond By-Product Gas Plant (with 2 Plates and 1 Fig.). By F. S. Sanderson - - - - - - 32

IX. Short Description of the Tar-Distillation Plant (with 1 Plate). By A. Gatley Lyon - - - - - - - 37

The Coal Industry of New South Wales (with inset table). By A. A. Atkinson - - - - - - - - - - 41

Manufacture of Cement from Blast-Furnace Slag. By Wm. Poole - - 81

An Improved Method of Dumping Spoil (with 1 Plate and 1 Fig.). By Geo. H. Broome - - - - - - - - - - 101

Experimental Electric Furnace (with 1 Fig.). By S. R. Mitchell - - 103

Some Notes on the Geology of Stannary Hills, North Queensland (with 5 Figs.). By G. B. Hope - - - - - - - - 109

Flow of Compressed Air in Pipes. By Johan Sarvaas - - - 121

The Human Side of Engineering. By F. Danvers Power - - - 131

DISCUSSIONS—

On the Coal Industry of New South Wales - - - - - 71

On Manufacture of Cement from Blast-Furnace Slag - - - - 97

On Experimental Electric Furnace - - - - - - 107

On the Geology of Stannary Hills, North Queensland - - - 119

SULPHIDE CORPORATION LIMITED WORKS, COCKLE CREEK, N.S.W.

Introductory.

It will be noticed, from the following contributed papers on the various plant, what an infinite number of parts are required to be kept in active operation in order to derive a resultant product of commercial value from the ores and materials received at the works. Crude ores and concentrates, in every degree of complex structure and resistance to treatment, are arriving daily from near and distant places, moreover their metallic contents are so varied that an outsider, unacquainted with the operations, would naturally wonder how it is possible that the rare elements are to be sorted out and classified into their true order, to meet industrial requirements. The proposition is necessarily not a simple one and owners of mining properties have naturally refrained from smelting their complex ores on account of the technical difficulties of attaining high efficiency and recovery of the metals, where limitations are imposed in procuring a variation of ores that lead to the best smelting and refining result. This difficulty obviously imposes many disabilities on the smelter, who is prepared to accept all such complex ores, and it may be said that were there not available a large weekly supply of lead concentrates from the Company's own mine at Broken Hill, of standard quality, much of the material being treated in the works to-day would certainly not be marketable.

In order to sustain full efficiency, each section of the works must maintain its true balance and synchronize with the requirements of such other departments as are dependent on its partially treated materials. This harmony of operations is not only imperative as regards tonnage output, but also relies on the condition of the resultant treatment by each plant, no large variations being permissible.

The various officers are, therefore, dependent on one another to keep the order of the operations flowing regularly. This is accomplished by constant intercommunication and observation, as

[This paper is separately bound, and may be, if so desired, detached complete from this number.]

Entrance to Works showing Residences and General Office.

Panorama of Refinery, Smelters, H. H. Plant and Acid Plant.

only in this manner can the high efficiency attained in the works in all departments be maintained.

Earlier smelting operations, particularly in this country, disregarded entirely by-product recovery, which is fortunately no longer the case to-day and is not permissible in any well-conducted works. From the coals, we have gas, fuel-oil, sulphate of ammonia and pitch. The roasting of the ores yields large quantities of sulphuric acid, which in its turn is converted into fertilisers. The bismuth and zinc contained in the ores received cannot be considered as anything else than a contamination, but will no doubt later be recovered as commercial products. At present, however, the one accompanies the lead, whilst the other is contained in the slags as discharged from the smelter and it is merely mentioned to indicate what a modern smeltery seeks to attain.

In order to convey to the members of the Institute some indication of relative size and proportion, it may be mentioned that upwards of 200,000 tons of various materials are dealt with annually in the works. From the treatment and manipulation of this tonnage about 31,000 oz. of gold, 2,500,000 oz. of silver, 28,000 tons of lead and 320 tons of antimonial lead are produced. From the roasting of the ores 19,000 tons of chamber acid is recovered, which again, in combination with phosphate rock, is converted into 25,000 to 30,000 tons of superphosphates to meet agricultural requirements. The output of sulphate of ammonia is about 800 tons, which is mostly exported. The fuel-oil representing no less than 50,000 gal. per annum is all used in the refinery. The nitric acid manufactured is mostly to satisfy the the acid plant and is made intermittently.

In commending to the consideration of the visiting members of the Institute the following descriptive articles on the various plants, it should be mentioned that those in charge of the departments, in conjunction with the Manager and Sub-Manager of the works, are responsible for the design, equipment and building of the whole establishment and I humbly give a meed of praise to their good work.

C. F. COURTNEY,

August, 1918. General Manager.

SHORT DESCRIPTION OF THE METHOD OF DISCHARGING AND SAMPLING ORE RECEIVED.

By Thomas Lawrie.

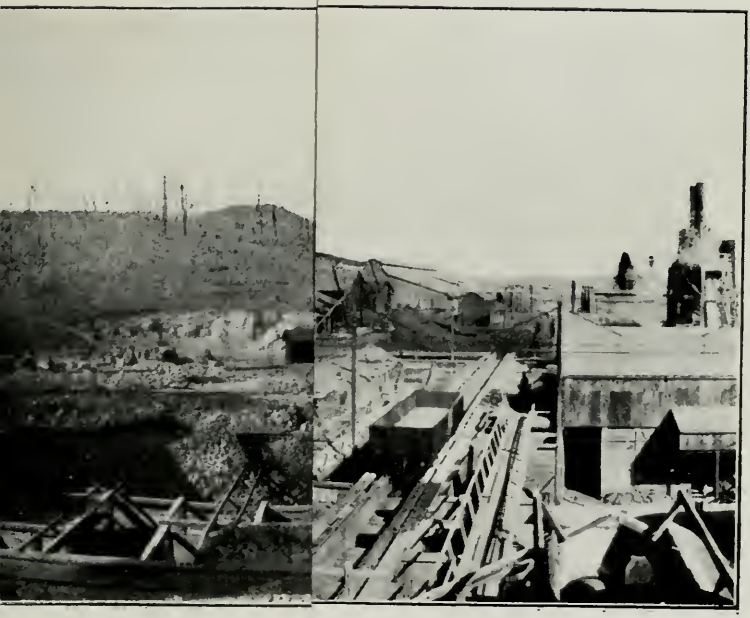
The Sulphide Corporation's works for the smelting of ores containing lead, gold, and silver are situated close to the Cockle Creek railway station, on the main Northern railway line, and are about 95 miles from Sydney and 10 miles from Newcastle. A branch line runs to the works, and siding accommodation and bins are provided for expeditiously handling all ores sent for treatment. The Corporation also possesses wharfage facilities at the port of Newcastle, where consignments of ores arriving by sea can be handled direct into railway trucks for conveyance to the works.

The greater portion of the ore treated at Cockle Creek comes from the Corporation's mine at Broken Hill, but a large quantity of other grades is also purchased and treated.

The Corporation does not smelt any consignments separately, but buys all shipments outright, consequently the purchased ore, on its arrival at the works, is first of all weighed and sampled to determine its value.

On arrival at the works, the contents of the trucks are weighed over a 60-ton tandem weighbridge, and then hauled to the sampling plant.

The sampling is effected by carefully taking a representative portion of all the ore in the consignment. If it is in the form of finely-crushed concentrates, a core is taken from each bag by means of an instrument like a cheese-taster. If the ore is crude—that is, in coarse lump form, as it comes from the mine—the method of taking the sample is somewhat different. With ore of ordinary values every fifth bag or every fifth shovelful is sent to the sampling mill. The balance is placed in bins for roasting or smelting, as the case may be. If it is of high



Panorama of Sample Room, Yard and Superphosphate Sheds.

value, the whole of the consignment is sent to the sampling mill. Mechanical automatic sampling has not been adopted, owing to the large variety of ores received at the works.

The portion taken for sampling is crushed to 1½-in. gauge and divided into two equal proportions, thus making a duplicate sample of every parcel. After passing through the crusher, the sample is coned on iron floors, and divided into four parts. Two parts are taken away, and the remaining two are again coned and divided, thus dividing the sample in halves every time. The ore is then broken to ¾-in. gauge, and goes through the same coning and quartering. It is passed through rolls, and crushed to ⅛-in. mesh, coned, and quartered down to about 4 lb. This is put through a grinder and reduced to a pulp, which will pass through a 120-mesh sieve. The sample is then well mixed, and divided into six equal parts, two of which form the seller's portion, two for buyer, and two for umpiring, if necessary. As already stated, the concentrates are sampled with an iron tube resembling a cheese-taster. The bags are stood on end, and the iron is passed diagonally through the ore from one corner to the opposite corner, and the tube twisted until the iron is full. This is shaken out into a tin cylinder. Another ironful is then taken from the opposite corner and placed in another tin. These are coned and quartered down separately, as in crude ores.

All fuel and fluxes, and other material arriving by rail, go direct to the various ore-bins or depots.

The storage room for the various ores and fluxes consists of three parallel sets of bins about 800 ft. long. Over the centre of each set of bins runs a 4 ft. 8½ in. gauge track, supported on a viaduct 13 ft. above the bin-floor level. Coal and coke, and a large proportion of the leady concentrates arriving from oversea, come into the works in hopper trucks, and these are discharged by simply dropping out the bottom of the hopper, the contents falling into the bin below. Other material which arrives in "D" trucks is shovelled out by hand. The ores, as they arrive, are classified into those which require roasting and those which can be treated direct at the smelter. These are again classified

according to their composition, and are bedded down in their allotted bin. Each bin, when full, is given a bed number, and an analysis of the contents is prepared for the metallurgist's use when making up his smelter charge.

The Corporation endeavours to keep a large surplus stock of fuel and fluxes on hand, which is stacked alongside various branch lines. These are reloaded into hopper trucks by means of a steam shovel and conveyed where required by one of the Corporation's locomotives.

A BRIEF DESCRIPTION OF THE NEW ASSAY OFFICE.

By E. Strangway-Jones.

On account of the increased work required from the assay office, owing to the large additions which have been made to the smelting and superphosphate plants during the last few years, it was found necessary to build a more extensive and up-to-date assay office than the one that had been in use since the starting of the works some twenty years back.

A site was chosen adjacent to the main office, so as to be free from smoke and dust. The building is constructed of red brick, the over-all dimensions being 109 ft. x 37 ft. The roof is of fibrous-cement slates, 31 ft. high, with a two-to-one rise, and overlaps the walls to the extent of 4 ft. 6 in. on all sides. Special care was taken to give light to all working benches, fume cupboards, and balance rooms. The main chemical room occupies the entire western end of the building, and the fire room the entire eastern end. Between these two rooms are the superphosphate, refinery, and gold-parting rooms on one side of the central passage, and three balance rooms, general office, and cloak room on the other side. The height of the roof affords ample space above these central rooms for storage purposes, and also maintains a fairly even temperature. The ceiling of the main chemical and fire rooms is carried immediately under the slates, which gives a total height in the centre of about 25 ft.

Main Chemical Room.—This is 34 ft. x 22 ft. Windows on three sides give ample light to three double working benches. A set of shelves runs down the centre of each bench, carrying the various reagents, and an electrical water-heater maintains a supply of hot distilled water. This heater is fixed at such a height that it is used in place of the ordinary wash bottle for washing precipitates, by means of a rubber tube fitted with a

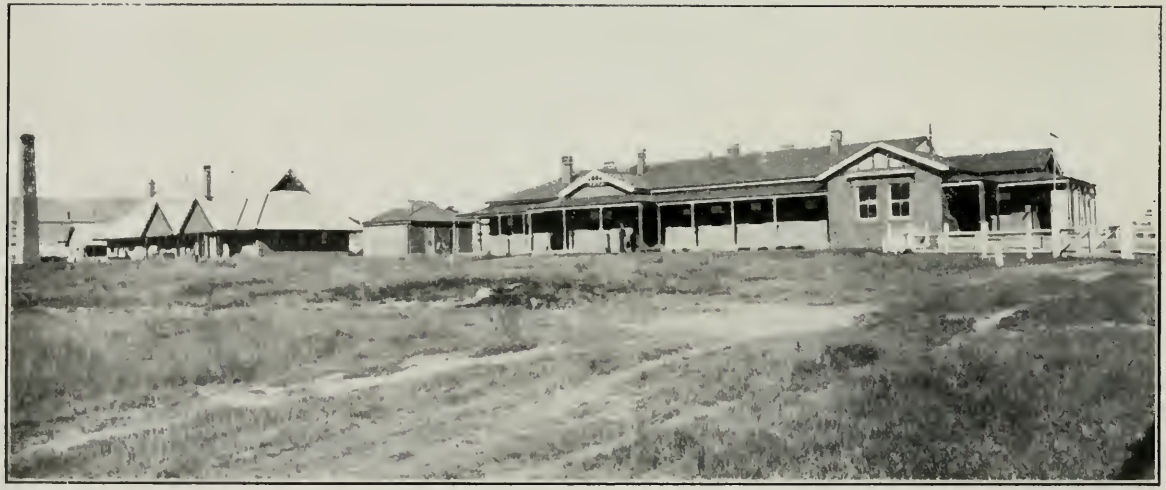
thumb clip. In an annexe off this room is placed a large sand-bath, on which most of the work is carried out. This sand-bath is heated by a coal fire outside the wall of the building. On the fourth side of the room are situated the fume cupboards, the benches being of slate, with tiled walls and sliding glass fronts. All fumes from these cupboards, and from the sand-bath, are drawn away through flues in the wall, which connect with a motor-driven Sirocco fan placed outside the building. The exhaust is led into the main stack.

Fire Room.—This room is a similar lofty room to the main chemical room, the dimensions being 34 ft. x 13 ft. 6 in., and is provided with six muffle furnaces, heated from outside by a coal fire burnt in step grates, and also with four coke-fired wind furnaces. Special effort has been made to reduce the temperature of this room by placing the muffle and wind furnaces directly under specially constructed hoods, which lead the hot air away through two 18-in. stacks fitted with revolving cowls.

Superphosphate Laboratory.—This consists of two rooms—one for main work and the other for special nitrogen distillations. Both are fitted with benches and fume cupboards similar to those in the main chemical room.

Refinery Laboratory.—This is fitted up with special apparatus for the estimation of silver by the volumetric method. All the heating for the superphosphate, refinery, and parting rooms is provided by electric hot plates and electrically-heated muffles. The hot plates are confined in a specially constructed double-glass case, which greatly retards heat radiation into the room.

Balance Rooms.—The balances rest on thick slate slabs supported on brick pillars built up from the ground through the floor. This arrangement greatly retards vibration of the balances.



General Office and Assay Office.

DESCRIPTION OF THE ROASTING OF SULPHIDE ORE BY THE HUNTINGTON-HEBERLEIN PROCESS.

By W. J. Jackson.

All ores arriving at the works which contain more than 3 % sulphur, together with all sands and other fine residues, are delivered to the roasting department. Those that are in a coarse condition are first sent to the crushing plant, consisting of 15 in. x 9 in. jaw crushers and two No. 5 Krupp mills. The ore is here crushed through a quarter mesh screen. Any pyritic concentrates high in sulphur are given a preliminary roasting, to bring the sulphur contents down to about 12 %, and the roasted material is delivered to the H. H. charge-making bins. Here the various ores, sands, residues, roasted pyrites, together with about 12 % of limestone, are made up into 1-ton charges in hopper trucks with bottom discharge. The trucks are elevated by hydraulic lifts to a tramway running over the roasting furnaces, and the contents are dropped into hoppers over each furnace, from whence the mixture is fed into the centre of each furnace by means of a Challenge ore-feeder.

A typical charge would contain :—

	%
Pb	50
SiO_2	7
FeO	7.5
CaO	6
MnO	2.3
ZnO	10
S	15

The mixture is now given a roasting in a modified Godfrey furnace, which brings the sulphur contents down to about 9.5 %. This furnace is gas-fired, and consists of a rotating circular hearth, 21 ft. in diameter, supported on a wheel race, and covered by a

low, dome-shaped roof. The charge, as already stated, is fed into the centre of the furnace through a hopper with a Challenge feed, and worked outward by blades attached to a fixed radial arm. At each revolution it is turned over and outward, the amount of deflection of the blades, which are adjustable, and the rate of rotation of the hearth determining the output of the furnace.

There are ten of these furnaces in two rows of five, each with an output of 30 tons per day (24 hours). They are driven by a duplicate steam engine of 18 h.p. (which allows of great variation of speed) off two main shafts by belt drives, each furnace requiring about 2½ h.p. One man looks after four furnaces.

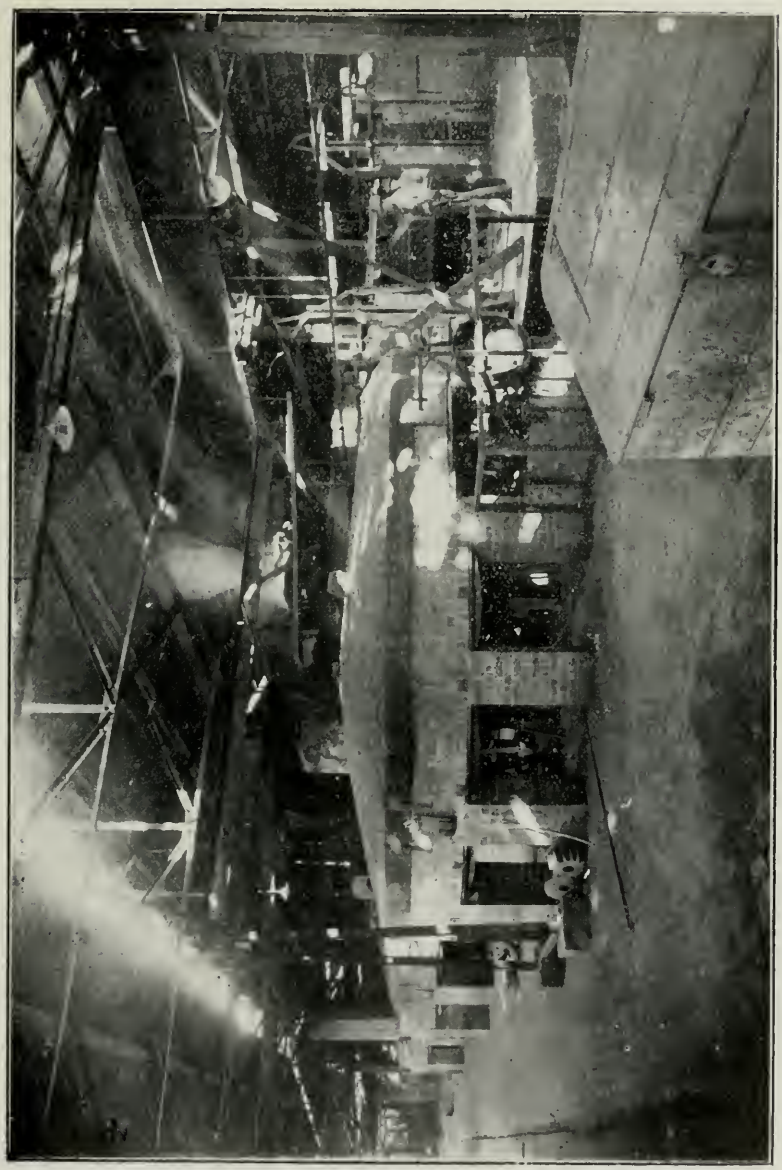
The object of the roasting in these furnaces is not only to reduce the sulphur contents down to about 9.5 %, but also to agglomerate the fine particles so that the roasted material will be in a granular condition, which form is most suitable for the subsequent treatment in the H. H. pots.

The gas for firing the roasters comes direct from the Mond gas plant, and is led into the brick combustion chamber of the furnaces through a gas burner, which consists of a cast-iron box through which a number of air pipes pass. The gas and air thus become mixed as they pass into the combustion chamber. Fitted to the front of the box is a wrought-iron sliding plate, perforated with a number of holes coinciding with the air pipes leading through the box.

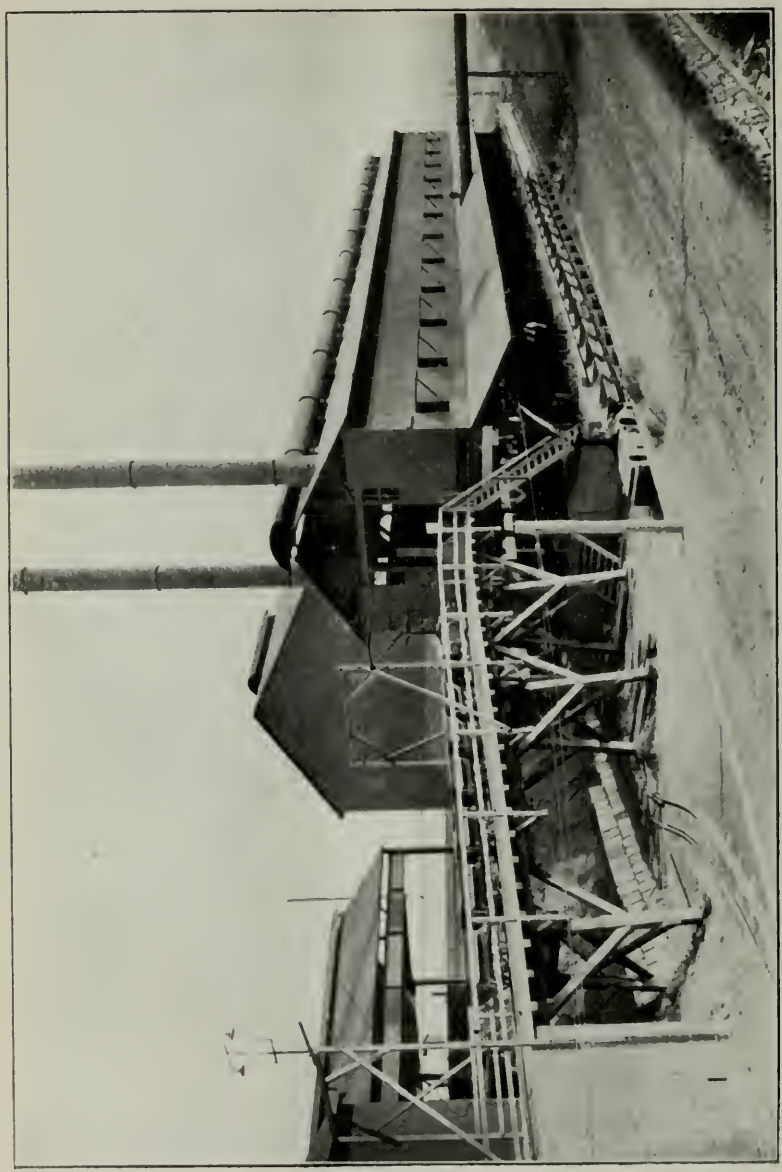
As the sliding plate is worked backwards or forwards it opens or closes the air holes, thus regulating the supply of air to the combustion chamber.

The supply of gas is controlled by a gate valve on top of the cast-iron box or burner.

The hot roasted ore is discharged at the periphery of the hearth into brick-lined boxes, which keep the material hot while sufficient is accumulating to fill one of the trucks, by which the roasted ore is conveyed to the H. H. pot-house. When sufficient ore has accumulated in the various boxes to make up a train-load, it is allowed to drop out of the hoppers into special side-tipping trucks, run on a 2-ft. gauge tram-line. These trucks are pushed



Rotary Roasting Furnaces.



H.H. Plant, Acid Chambers in background.

Interior of H.H. Shed showing Charging Floor.

out on to the main line, where they couple together automatically, and are hauled by a 5-ton electric locomotive up a 4 % incline into the H. H. pot-house. This plant consists of 24 pots, each capable of holding 5-tons. The charge floor is built up level with the top of the pots, which facilitates charging.

The H. H. pots are cast-iron of elliptical form, hung on hollow trunnions. About 6 in. from the bottom a perforated plate fits horizontally. This is held in position by four studs, which are fixed into the sides of the pot, and project about 1 in. over the top of the plate. The space under the plate acts as a wind box.

The air-blast passes through the hollow trunnion, down a pipe outside of the pot, and enters the wind box. There is, therefore, no necessity for detaching and re-attaching the air pipe after each tipping of the pot.

A hood rests on the flanged edge of the pot, making a fairly close joint, which is made air-tight by a lute consisting of flue dust and clay. It is provided with two small doors or inspection-holes, through which the charge is barred when blow-holes make their appearance. They are also fitted with a telescopic arrangement, which allows the hoods to be easily swung up during charging or tipping operations. The hot roasted ore, when it arrives at the pot-house, is tipped direct into the pots. The charge is levelled, and an air-blast of from 10 to 12 oz. pressure is turned on. Thermo-chemical action takes place : the ore being desulphurized to a low point, and the heat generated by the reaction is sufficient to fuse or sinter the mass, with the exception of a little " fines " on the top of the pot, which are returned to the raw mixture, and worked off in small amounts to each charge. It takes from six to eight hours to finish the operation. The pot is then turned over, and the sintered mass falls on to the breaking floor beneath, is cooled by spraying with water, and broken up to 6-in. lumps. One essential difference in the process to the general practice is that the charge, after roasting, is not wetted and cooled, but arrives at the H. H. pots at a dull red heat. No fire is built in the pot, the heat

retained by the ore being sufficient to start the reaction when the blast is turned on, whereby there is a considerable saving in fuel and labour.

The gas pipes from the hoods connect with four main overhead pipes, two of which convey the gas suitable for acid-making to the acid chambers. The other two are used for by-passing the unsuitable gases to two iron stacks, which discharge into the atmosphere. As the operation develops, it is expected that the whole of the gases will be used for acid-making, about 80 % of the gases being serviceable for this purpose.

To one trunnion of each pot is fitted a wheel about 4 ft. in diameter, which has a heavy toothed boss. These teeth engage with a pawl, which holds the pot in position while working. When it is ready to tip, the pawl is knocked out, a chain is passed round the wheel, and the pot pulled over by means of a two-ton block-and-tackle. The sintered mass, weighing about four tons, falls on to the breaking floor, 10 ft. below. This floor, which stands about four feet above the surrounding level, has been built up by running in molten slag to a depth of six feet. The block has been covered with concrete, reinforced with 60-lb. railway irons laid side by side. These overhang by about one foot, and project just over the top of the side-tipping trucks, which stand on a line running each side of the breaking floor. This, together with the fact that the floor has a slight fall to each side, enables the sintered product to be easily pushed into the charge trucks. When full they are drawn away to the smelters by the five-ton electric locomotive already mentioned.

The blast for the H. H. pots is supplied through a 20-in. main from a Roots blower, driven by a 60 h.p. variable-speed motor, the actual power required being about 30 h.p.

DESCRIPTION OF THE SULPHURIC ACID, NITRIC ACID, AND SUPERPHOSPHATE PLANTS.

By J. H. M'Feeters.

The following paragraphs represent an endeavour to describe briefly the equipment used for the manufacture of sulphuric acid and superphosphates by the Corporation.

Sulphuric Acid Plants.

Two separate units are in operation, No. 1 Plant working on sulphur dioxide generated from pyritic ore, No. 2 Plant working on sulphurous gases obtained from the Huntingdon-Heberlein desulphurizing process. The latter plant is unique in being the first installation for the successful use of these gases.

no. 1 plant.

The sulphur dioxide for this unit is obtained by the roasting of pyritic ore in the Herreshoff furnaces. The type of furnace is the "New Herreshoff Furnace," the special feature of which is an air-cooling device for the rabble arms and central column of the furnace, also enabling control of the temperature of roasting. There are five of these furnaces attached to this unit. Working on ore of 36% and over of sulphur contents; no further fuel is required after once having been started.

Dust Collectors.—As the sulphur dioxide is given off during the process of roasting, it is drawn through dust collectors by the suction created by a lead fan, to be described later. Each furnace has a separate dust collector, which consists of a large rectangular brick chamber, from the top of which are suspended a number of lengths of $\frac{1}{4}$-in. round iron, forming, as it were, a series of loose curtains through which the gas must pass. The dust drops from these curtains to the bottom of the chamber, from which it is withdrawn from time to time. The gases then unite in a common flue and pass to the Glover tower.

Glover and Gay-Lussac Towers.—The Glover tower, the chief functions of which are denitration, concentration, and cooling, consists of a lead-lined tower 30 ft. high, packed with hard-burnt chemical brick in checker formation. The lead linings of this tower are much heavier than the others of the system, owing to the violence of the chemical reactions taking place therein, and to the temperature of the entering gases, which average about 300° C.

The Gay-Lussac towers, the function of which is the absorption of the nitrogen oxides liberated at the end of the process, are two in number, and similar in section, height, and packing to the Glover tower.

Chambers.—There are five in this set, and of the following dimensions :—

Nos. 1 and 2	19 ft. 6 in. high,	25 ft. wide,	97 ft. 6 in. long.
No. 3 ..	18 ft. 6 in. ,,	20 ft. ,,	96 ft. ,,
No. 4 ..	19 ft. 6 in. ,,	25 ft. ,,	60 ft. ,,
No. 5 ..	19 ft. 6 in. ,,	25 ft. ,,	36 ft. ,,

The curtains and tops of the chambers are built with 7-lb. lead, and the bottoms of 8-lb. They are connected by 26-in. lead pipes with each other and with the towers—one line leading from the Glover tower to the chambers, and the other leading from the last chamber to the Gay-Lussac towers.

Lead Fan.—This fan is placed between the Glover tower and the first chamber. The casing and impellers are made of antimonial lead, the impellers being mounted on a 3-in. steel shaft covered with lead sleeves on that part of its length exposed to the acid gases. The fan is belt-driven from a 5 h.p. variable-speed motor, and runs about 240 r.p.m.

Gas Circuit Through Towers and Chambers.—The gas is drawn from the Herreshoff furnaces through the dust chambers and Glover tower by the suction of the fan, which then forces it through the chambers and Gay-Lussac towers. During the passage of the gas through the chambers, the chemical reactions, resulting in the formation of sulphuric acid, take place, the water necessary to these reactions being supplied in the form of an extremely fine mist by a number of Benker sprays. These

reactions are so controlled that the gas issuing from the last chamber contains practically no sulphur dioxide, and only free oxygen and nitrogen oxides. These nitrogen oxides are absorbed by the acid flowing down the Gay-Lussac towers, and are returned to the system by way of the Glover tower. These nitrogen oxides, which hasten the oxidation of sulphur dioxide to sulphur trioxide during the reaction process in the chambers, are originally introduced through the Glover tower in the form of nitric acid.

NO. 2 PLANT.

This unit, operating on gases generated by the Huntingdon–Heberlein desulphurizing process, presents several unusual features; consequently, the design of this plant was modified to meet conditions which might reasonably be anticipated by obtaining gas from such a source.

To some extent the plant is practically a combination of both the chamber and tower systems of acid making, and consists of four chambers and seven towers.

Towers.—Of the seven in the system there are two Glovers, two inter-chamber towers, one regulator, and two Gay-Lussacs.

The Glovers and Gay-Lussacs are rectangular in section, and packed similarly to those of No. 1 set, the former being 25 ft. high and latter 30 ft.

Owing to the comparatively low temperature of the gases entering the Glover tower, its function as a concentrator is *nil*, but, by observing several conditions, it still serves its purpose as an efficient denitrator.

The inter-chamber towers are 20 ft. high, and also packed with chemical brick. Their chief function is to keep alive rapid chemical reaction by thoroughly mixing the gases, and so minimizing the retarding effect on chemical activity caused by carbon dioxide present as an impurity in the gas.

The regulator is similar in design to the inter-chamber towers. It is placed between the last chamber and the Gay-Lussacs. Its chief function is to prevent any sulphur dioxide entering the Gay-Lussacs—a condition which might easily occur when working on gases liable to sudden variations of sulphur dioxide contents.

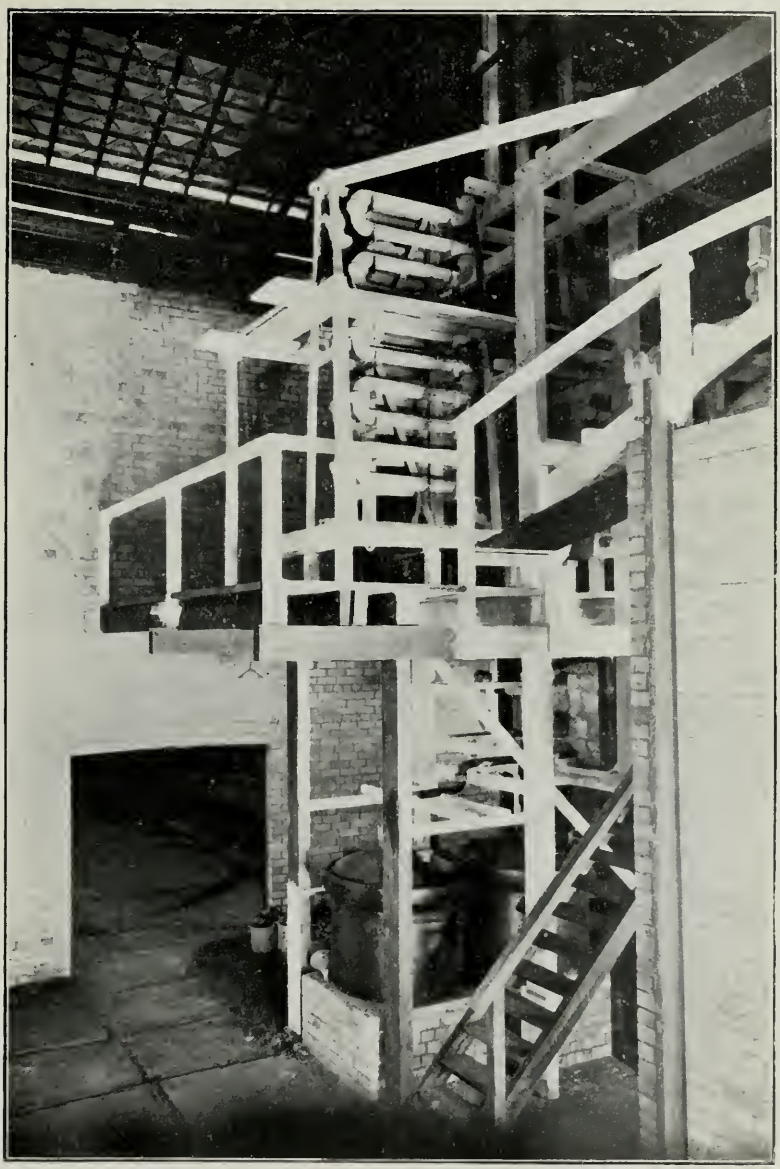
Chambers.—The chambers of this set are built narrow and high, with the view of decreasing any tendency towards the formation of zones of sluggish gas-movement, and also for being well adapted to the use of water sprays. They are all comparatively short, and, in order to secure the requisite and proportional chamber volume, one to another, the first two are grouped abreast and work in parallel. These two act virtually together as the first chamber of the series. Regarding these two as one, the proportion between the first, second, and third chambers is approximately 4 : 2 : 1. The chamber dimensions are :—

Two chambers in parallel, each	30 ft. high,	20 ft. wide,	80 ft. long.
Following chamber ..	30 ft. ,,	20 ft. ,,	80 ft. ,,
Last chamber	30 ft. ,,	20 ft. ,,	40 ft. ,,

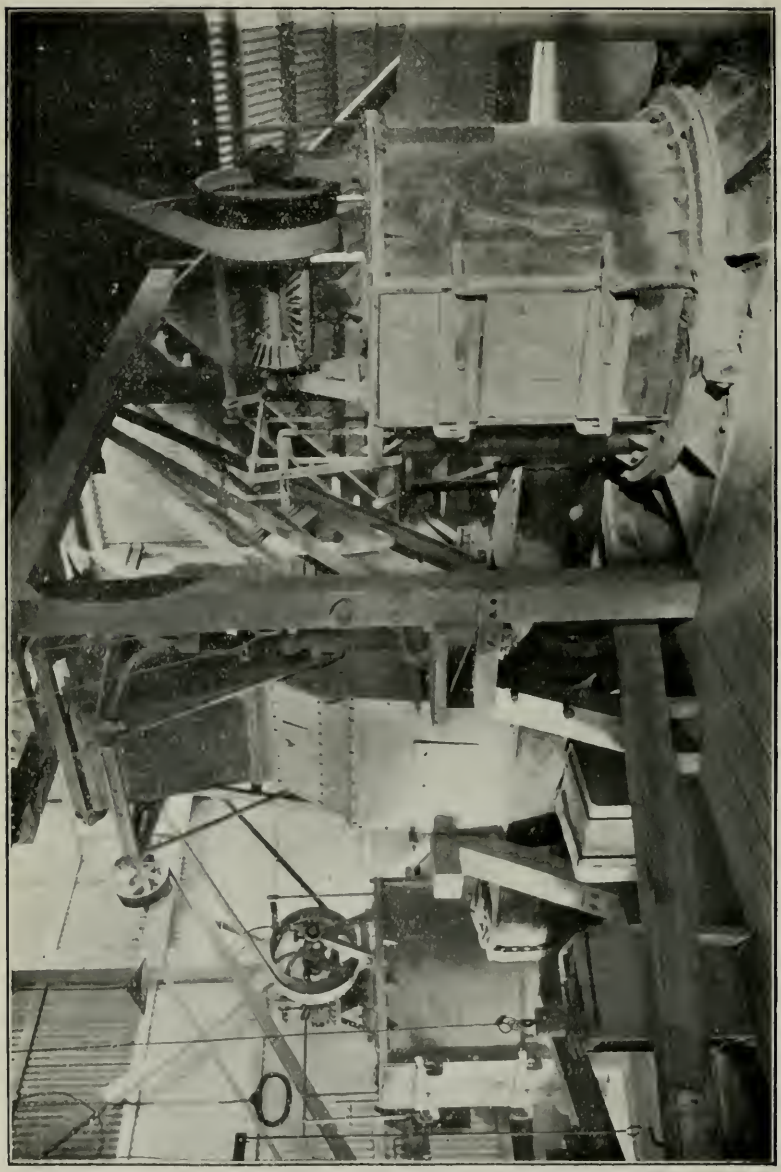
Gas Circuit.—The gases are drawn from the H. H. plant through the dust chambers and Glover tower by the suction of a lead fan, similar in design and position to that of No. 1 plant. In front of the fan these gases divide, a portion going into No. 1 chamber, and a portion into No. 2 chamber, working in parallel ; the gas volumes passing into these chambers being controlled by dampers. The issuing gases combine in a 30-in. pipe, common to both chambers, and are forced through the first inter-chamber tower into the following chamber. From here they pass through the next inter-chamber tower into the last chamber, through the regulator, and thence out of the system through the two Gay-Lussac towers, working in series.

The greater part of the production of these two plants is used on the works, chiefly in the manufacture of superphosphate. A considerable amount is also concentrated to commercial strength in lead pans, and sold to various consumers. This concentrated acid is transported in iron tank cars, the capacities of which vary from 8 to 15 tons.

Attached to this unit is a small sulphur burner, capable of burning three tons per 24 hours. This will be used to supply sulphurous gas whenever the H. H. plant might be closed down for overhaul, or through the closing down of the blast furnace.



Nitric Acid Still and Condensers.



Superphosphate Weighing and Mixing Machines.

Nitric Acid Plant.

The nitric acid required for use in the Glover tower is manufactured in a 2-ton plant, in a building attached to No. 1 sulphuric acid plant. This particular unit has only recently been installed, and embraces the latest improvements in apparatus for nitric manufacture. Its outstanding features are the unusually large retort and the silica-ware condensers.

The plant consists essentially of three principal parts—retort, condensers, and receivers.

Retort.—The retort is cup-shaped, and is set in brickwork. It is fired from beneath, and the flues are so arranged that the hot gases of combustion circle twice round the retort before reaching the chimney stack. Both the retort and its cover are castings, made of special acid-resisting metal known as Narki metal.

Condensers.—The condensers consist of a number of $3\frac{1}{2}$-in. pipes, 3 ft. long. Plate VII. shows the arrangement of the pipes, which are built up in parallel tiers, having ten pipes in a set. There are four of these sets of condensing tubes working in parallel from a common receptacle. All the pipes are made of fused silica ware. known as "vitreosil," which, besides being acid-proof, withstands sudden changes of temperature.

Receivers.—The receivers are three in number, and of 100 gal. capacity each. They are made of acid-resisting stoneware, cylindrical in shape, and 3 ft. in diameter.

Modus Operandi.—The retort is charged with two tons of nitrate of soda and the requisite amount of strong sulphuric acid, and a slow fire started in the grate beneath. After some time the liberated nitric begins to distil over. It escapes from the top of the retort through 8-in. vitreosil pipes, which lead to a receptacle, also of vitreosil, communicating both with condensers and receivers. During its passage through these pipes the nitric is condensed, and runs into any one of the three receivers.

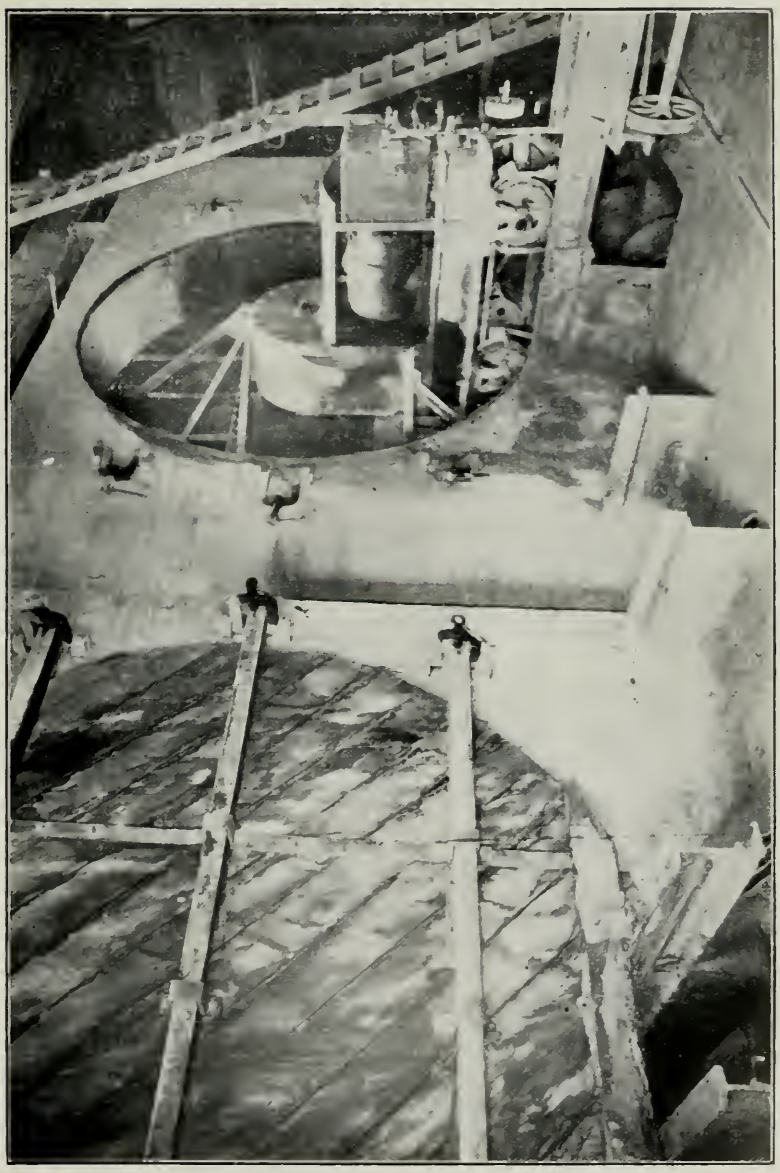
Superphosphate Plant.

In theory the process of manufacture of superphosphate is in itself simple.

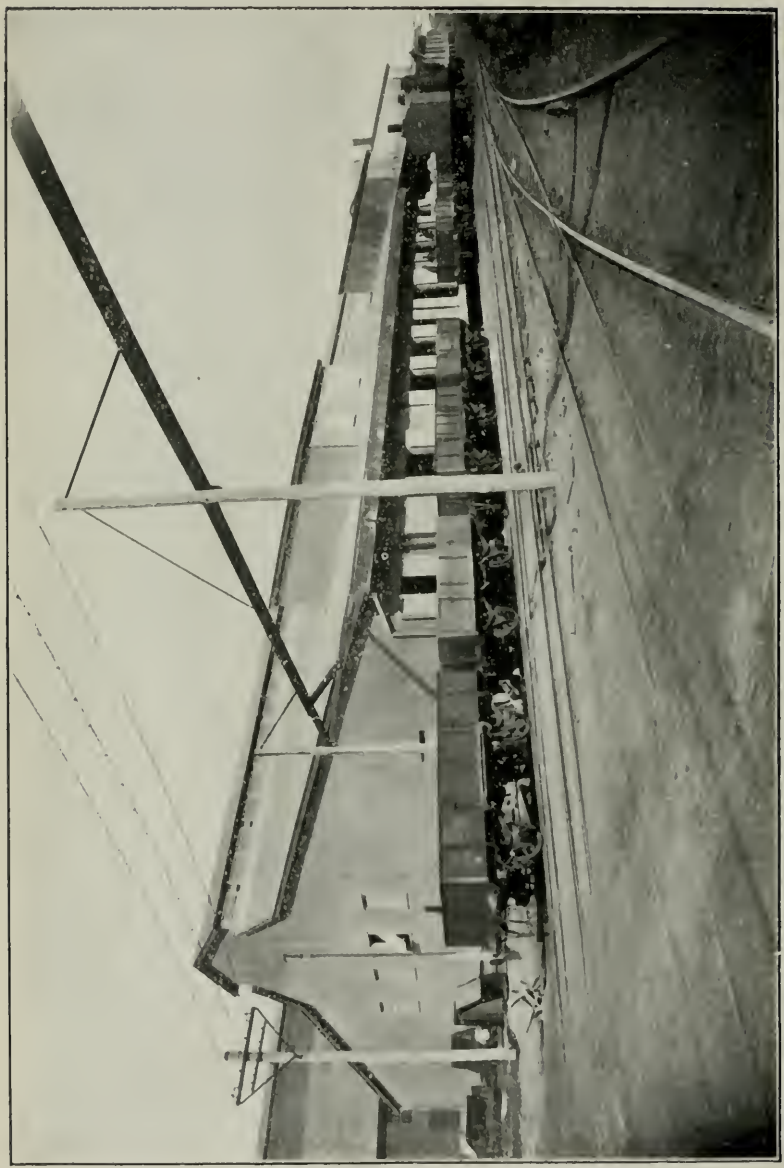
The raw phosphate rock contains phosphoric acid as tribasic phosphate of lime, insoluble in water, and consequently not assimilable by plants. Therefore, the process of manufacture consists in converting this insoluble phosphoric acid into the "water soluble" or "citrate soluble" form in which it is available as a plant food. This is done by treating the raw phosphate rock with sulphuric acid, which converts two parts of the lime into gypsum, leaving one part of the lime combined with all the phosphoric acid as the monobasic or water-soluble phosphate of lime. This product is known as "superphosphate"—the prefix "super" denoting that the ratio of phosphoric acid to lime is in excess of that of the normal tribasic phosphate. The phosphate rock is imported entirely from the Pacific Islands, the best-known deposits being at Ocean, Makatea, Nauru and Angaur Islands. They contain a higher percentage of phosphoric acid than any other known deposit, and range from 82 % to 87 % tribasic phosphate of lime.

Cargoes of phosphate rock are unloaded into trucks on the Corporation's wharf at Newcastle, thence by rail to the works at Cockle Creek. These trucks run over the top of the large storage bins, and are there discharged. The present capacity of these bins is 6000 tons. They will shortly be increased to 10,000 tons capacity.

The first step in the manufacture is the crushing of the rock to the degree of fineness which allows rapid reaction between the raw material and sulphuric acid. The rock is first reduced in size by a gyratory crusher, and thence through a series of screens and rolls until a sufficiently fine product is produced. The power for the crushing mill is supplied by two direct-current motors of 75 and 50 h.p. respectively. The finely-crushed rock is elevated from its storage bin to the mixing floor, where it is conveyed by screw conveyers to an automatic weighing machine discharging into the mixer. As the crushed rock runs into the mixer, it also receives a measured quantity of sulphuric acid, with which it is mechanically mixed. The mixers are totally enclosed, and communicate with an exhaust fan, which removes any corrosive gases



Dens and Cutting-out Machine.



View of Old Superphosphate Storage Shed.

given off during the decomposition of the rock. When mixed (a process occupying about one minute) the semi-liquid mass is discharged through the bottom of the mixer into reinforced concrete "dens" below. These "dens" are circular in section, 25 ft. long, and have a capacity of 55 tons. Here chemical reactions between the rock and acid continue, resulting in the semi-liquid material "setting" to a fairly-solid mass. When "set" the end and bottom doors of the den are removed, and the superphosphate cut out by a mechanical excavator. As the material is cut out it is carried by belt conveyers and elevated to the "rasper," where drying, granulation, and aeration take place. A definite quantity of clean sand, free from dust, is fed on to the conveyer belt before the superphosphate reaches the "rasper," in order to maintain the standard quality or grade, and produces an effective free-drilling fertilizer. From the "rasper" it is elevated to the conveyer belt running along the top of the storage shed, where a movable tripper permits it to be discharged into any desired section. There are two large storage sheds with a combined storage capacity of 35,000 tons, and the following are the dimensions of the sheds :—

No.	Length.	Width.	Height from floor to ridge cap.
1	400 ft.	119 ft.	48 ft.
2	400 ft.	126 ft.	59 ft.

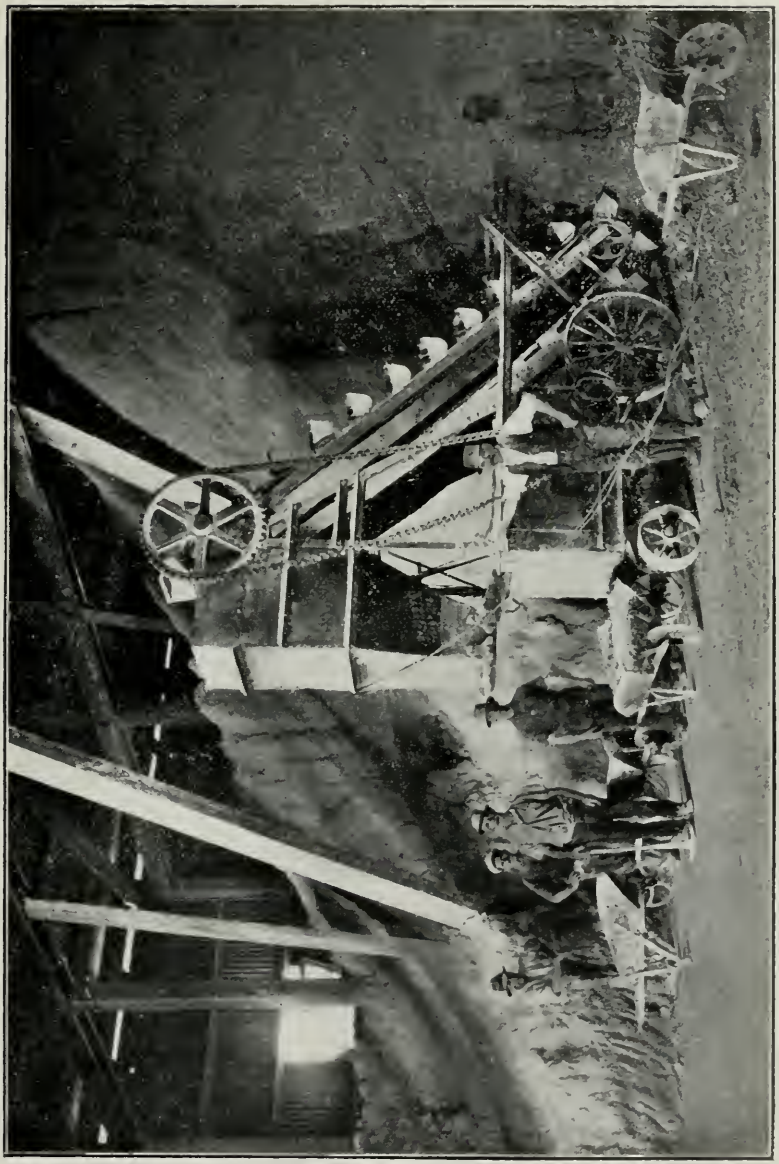
It is in these storage sheds that the final chemical reactions take place, and from which the fully-matured superphosphate is bagged ready for market.

The bagging is done by special mills, of which there are three in each shed.

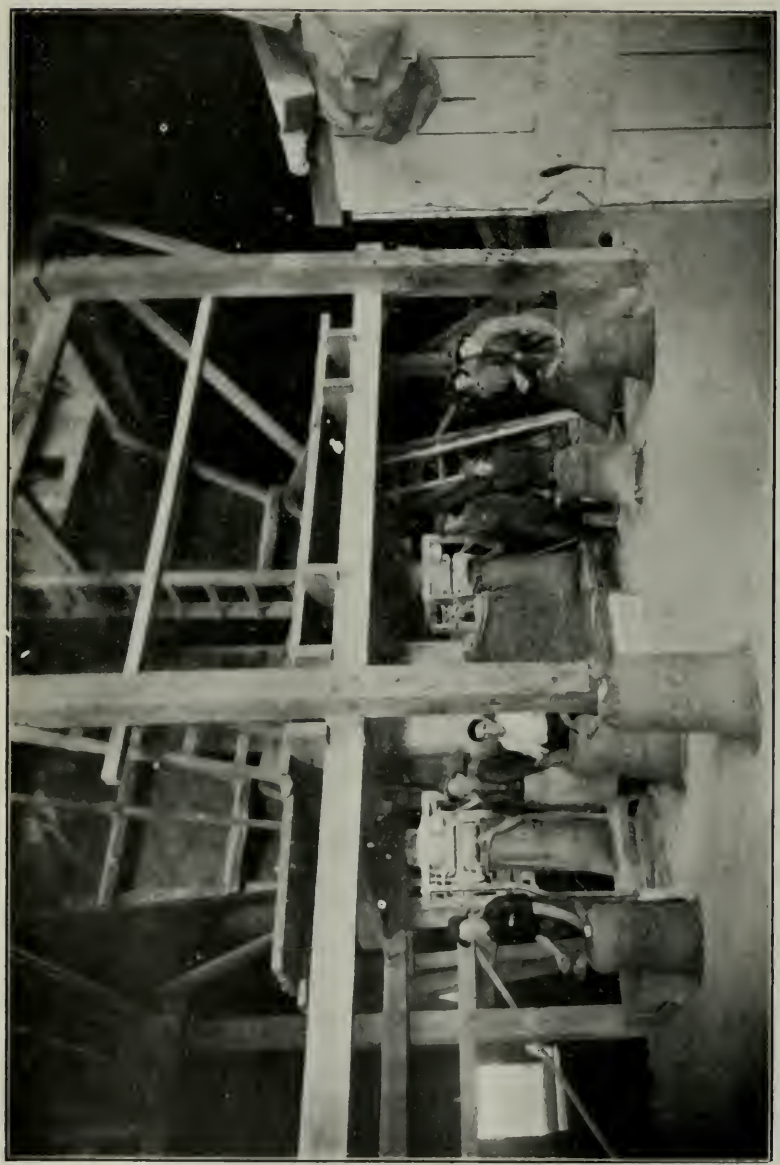
The superphosphate from the pile is broken up and loaded on to conveyers or barrows by a mechanical loader. The material is then taken to the bagging mills, where it is screened, the screenings dropping into small storage hoppers. Beneath these hoppers are placed the weighing machines. These machines deliver a set weight only to the sack, and as soon as that weight is attained they automatically cut off the flow of material to the sack. The superphosphate is put up in standard cornsacks,

12 bags weighing one ton. From the bagging mills the superphosphate is loaded for transport into Government trucks placed alongside the platforms attached to each shed.

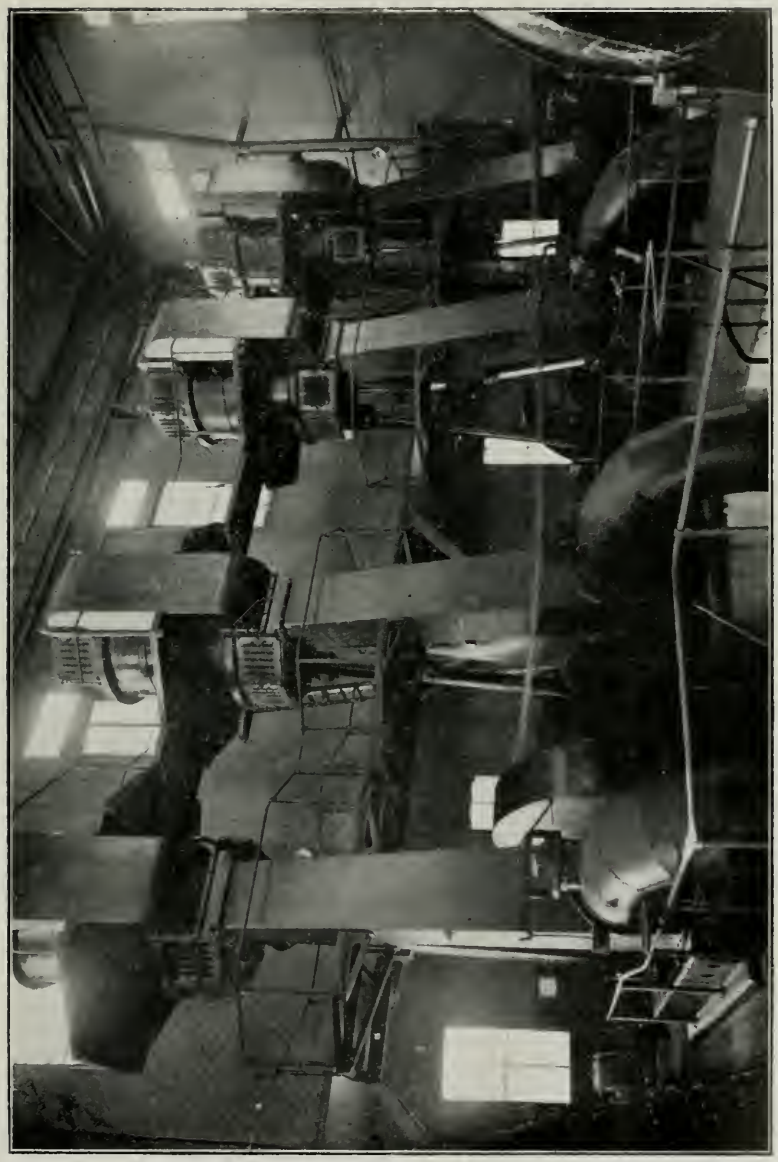
Besides superphosphate complete, mixed manures are manufactured and marketed. There are two points of special interest about these mixed manures: first, potash is used in varying quantities in the manures, which is now being obtained from burnt seaweed (kelp), coming from works recently established in Tasmania; the second point of interest is that the ammonium sulphate is obtained as a by-product from the power-gas plant.



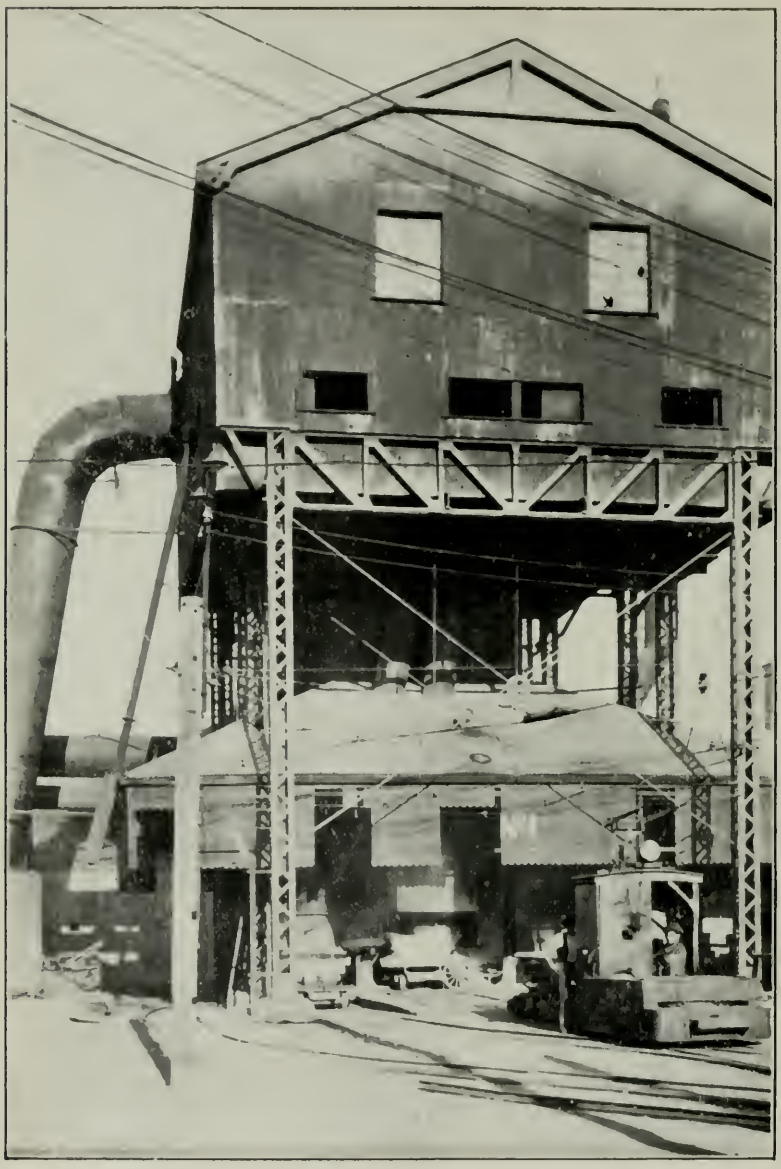
Superphosphate Loader.



Superphosphate Bagging Machine.



Blowing Engines.



No. 1. Blast Furnace.

A BRIEF RÉSUMÉ OF THE SMELTING PLANT.

By Guy Courtney.

The Company's smelting equipment consists of three blast furnaces, supplied with blast from two sets of vertical piston blowers, each capable of delivering 8000 cub. ft. of air per minute at a pressure of 60 oz. per sq. in. Each blower is belt-driven by a 130 h.p. motor. The maximum speed of the blowing engine is 35 r.p.m.

No. 1, the largest of the three blast furnaces, has a crucible area of 49.5 sq. ft., and measures 11 ft. 6 in. x 5 ft. at the tuyeres. From tapping floor to feed floor measures 35 ft. 9 in., and holds, when full, 100 tons of charge. Blast enters through thirteen 3-in. tuyeres at 60-oz. pressure. Working normally, this furnace is capable of treating 300 tons of charge, exclusive of returned slag and coke, per 24 hours, with an output of 100 tons of lead. Tapped slag flows into a C.I. forehearth mounted on wheels, where any lead and matte is caught, and the slag overflows into a 3-ton cast-iron pot, in which it is drawn away by an electric locomotive and poured over the dump.

Forehearths are replaced several times a shift, the full ones being taken to the matte shed, where they are drained of matte and lead, and the shells knocked out. Any slag tapped out of these forehearths, together with the shell, is returned to the blast furnace.

No. 2 blast furnace measures 8 ft. 2 in. x 4 ft. 4 in. at the tuyeres, has a crucible area of 29.3 sq. ft., and is 34 ft. high from tapping floor to feed floor. Blast is delivered through nine 3-in. tuyeres at 55-oz. pressure. This furnace has a capacity of 250 tons of charge in 24 hours. The forehearth is similar to that already mentioned.

No. 3 blast furnace measures 5 ft. 6 in. x 2 ft. 9 in. at the tuyeres, and has a crucible area of 15 sq. ft. This furnace is chiefly used for smelting drosses and antimonial slags from the refinery.

In all cases the slag is taken out to the dump in the same type of slag-pot, and by the same means of locomotion.

The charging arrangements consist of a series of bins, six in number, situated conveniently at the back of No. 1 furnace, and connected with all three furnaces by a 2-ft. gauge tramway system.

Two jaw breakers reduce all materials to about 4-in. mesh, and feed two bucket elevators, which lift the fluxes and ores to the bin top, and deliver by means of movable chutes into any required bin. When full, there is enough material to last the large furnace for about 36 hours. A gang of men, working day shift only, keeps the bins charged. Each bin is provided with a hopper scale, the hopper of which is divided down the centre into two compartments, so that on opening the bin door the material is split by the partition into two approximately equal parts, equivalent to two or four charges, according as to whether the total charge has been weighed out for four or eight charges.

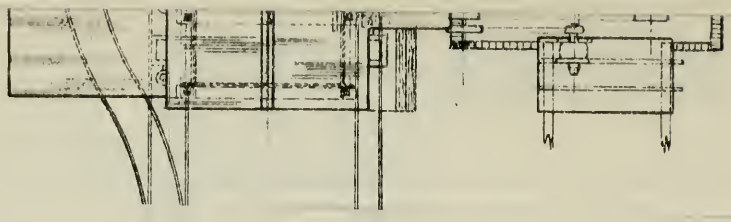
By weighing the charges in this way, the element of error is reduced to a very small figure.

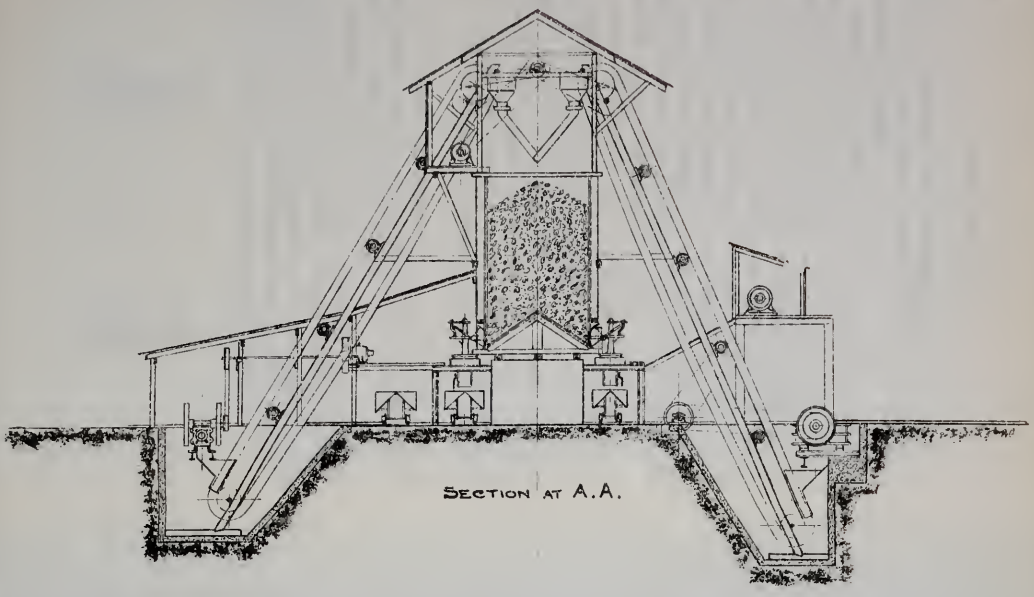
Running underneath the scale hoppers is a 3-ft. track, on which travels a special type of charge truck, divided into four compartments by plates at right angles to one another. In order to facilitate the discharge of the fluxes, the truck is constructed on the saddle-back principle, and has a door to each of the four compartments. It is, therefore, possible to wheel four charges at once, and to discharge them independently of one another.

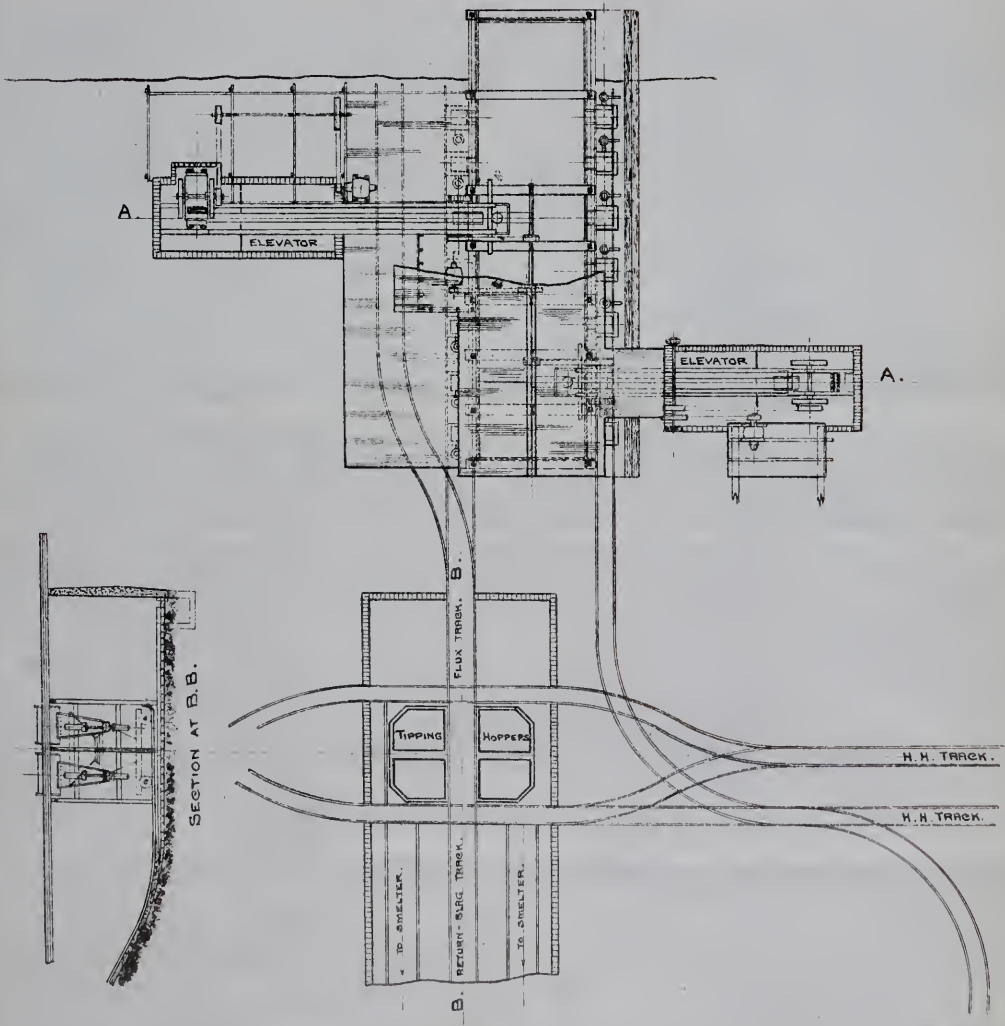
From the flux truck the charge goes into a set of four tilting hoppers, built to the level of the floor, and over a pit in which is the truck for hauling the complete charge to the top of the furnace. These hoppers are tilted by means of hydraulic rams operated by control levers.

The flux line runs down the centre of the hoppers, while the H. H. product is brought to either side and crosses at right-angles to the flux line.

The H. H. mixture, which constitutes three-quarters of the full charge, is hauled from the H. H. pot-house by electric locomotives. A rake of 10 trucks, equivalent to ten charges, is brought up and







ARRANGEMENT OF SMELTER CHARGE BINS & CHARGING HOPPERS.

COCKLE CREEK WORKS.

run over a weighbridge, where the weight is adjusted. It is then taken on to the charge-making floor and left in position for the charge-makers to handle.

The making-up of a charge is as follows :—The flux truck is run under the scales and placed in such a position that the flux, on discharging from the scale hoppers, will split either into two or four charges, as required. Having carried out this operation with all the required fluxes, it is run down to the four tilting hoppers, and one compartment discharged into each, a charge of coke having previously been placed in the bottom. A truck of the H. H. product is then brought up and its contents dumped in, after which follows a truck of returned slag from the matte shed, consisting of slag-pots and forehearth shells.

The returned slag cars are of a similar construction to the flux waggon, except that they are not divided into four compartments, but only into the two made by the saddle.

Having completed the charge, the tilting hopper discharges into a charge truck beneath. This truck is hauled up an inclined way to the top of the furnace by electrical power, and so arranged that, as a full truck goes up, an empty one descends on the other side.

On arrival at the furnace feed-floor, the feeder releases a catch, and the hopper, being slightly top-heavy, turns completely over, discharging its contents into the furnace.

The Sulphide Corporation, being a Customs smelter, a large variety of ores have to be treated, resulting at different periods in furnace slags of varying composition. In consequence of this, it is difficult to give any definite type of slag run, but, as an illustration, the type being run at present is given below :—

	%
Pb	.7
FeO	36.4
MnO	1.6
CaO	17.2
SiO_2	24.5
ZnO	12.0

This slag, as before mentioned, is tapped into cast-iron elliptical pots and poured over the dump.

The lead is tapped into small cast-iron pots, and run across to the drossing furnace. This is a small reverberatory of about seven tons capacity, from whence two products are obtained—lead bullion (carrying most of the gold and silver) and dross. The dross, on being removed from the top of the lead, is still fairly "wet," and is transferred to a liquating furnace, where most of the lead is sweated out and returned to the drossing furnace. The more or less "dry" dross is allowed to accumulate till there is sufficient to warrant No. 3 furnace being blown in, and the accumulated stock smelted.

The lead from the drossing furnace is tapped into two rings of 100 moulds each, which revolve on their own axes. On cooling, the bars, which weigh about 85 lb. each, are stamped with a letter and number, in lots of 2600 bars, or nearly 100 tons, and sent for treatment to the refinery.

Lead matte, caught in the forehearths, is tapped into cast-steel moulds, set in a revolving ring, and from thence carted to the Krupp mills at the roasting plant, and crushed ready for incorporating in the H. H. mixture.

Any lead found in the forehearths, which has not been previously tapped at the smelter, is cast into moulds and sent to the drossing furnace.

In order to remove the shells, the forehearth is run into a tipping cage, which turns upside down, when, by means of a bar, the forehearth shell is knocked out.

The slag shells remaining in the slag cars, after the liquid contents have been poured over the dump, are also brought back to the matte shed, and tipped alongside the shells from the forehearth. A 3-ft. tramway runs through this building on a track sunk into the ground, so that the top of the return slag trucks are on a level with the main floor. The various shells are broken up, loaded into these trucks, and drawn to the smelter-charge hopper by an electric locomotive. The only slag which is added to the smelter charge is that sufficient to keep these shells worked up.

DESCRIPTION OF LEAD REFINERY.

By R. E. Cowles.

The building is a lofty, well-ventilated one of hardwood frame, with galvanized-iron walls and roof, and consists of five spans running north and south, covering a total length of 236 ft. Each span is composed of nine bays of 13-ft. centres, making the total width of the building 117 ft. The refinery is situated conveniently at a distance of 100 yds. from the smelters.

Through the third span of the building runs a 5-ton electric overhead travelling crane, of a 3-motor type, with a span of 29 ft. The crane runway extends over a railway line, which connects the smelters to the refinery. This crane is used for handling bullion, coal, melting kettles, lead pumps, &c.

A 3-ton crane of similar type, but with a 50-ft. span, runs through the fifth span of the building, and also extends over the railway line already mentioned. This crane is used to load the soft lead into railway trucks, or to stack lead awaiting shipment in the area covered by the crane's operations.

The installation is in two units in parallel, each unit consisting of :—

One 50-ton Copper-drossing kettle.
One 46-ton Antimony softener.
Two 44-ton Desilverizing pans.
One 40-ton Refiner.
One 38-ton Market kettle.
One Moulding ring.

Common to both sets :—

One small furnace for working up skimmings and drosses.
One Antimony dross furnace.
One Gas producer for retort furnace.
One four-bottle regenerative gas-fired retort furnace.

Two single-bottle oil-fired tilting retort furnaces.
Three concentrating cupels.
Two finishing cupels.
Electrolytic parting plant.
Gold and silver melting furnaces.

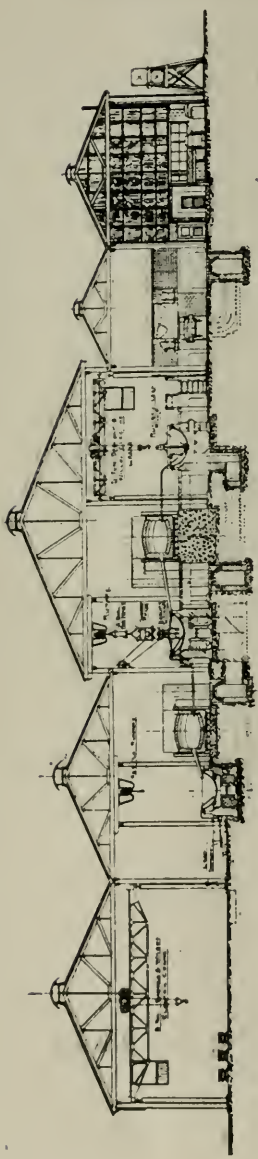
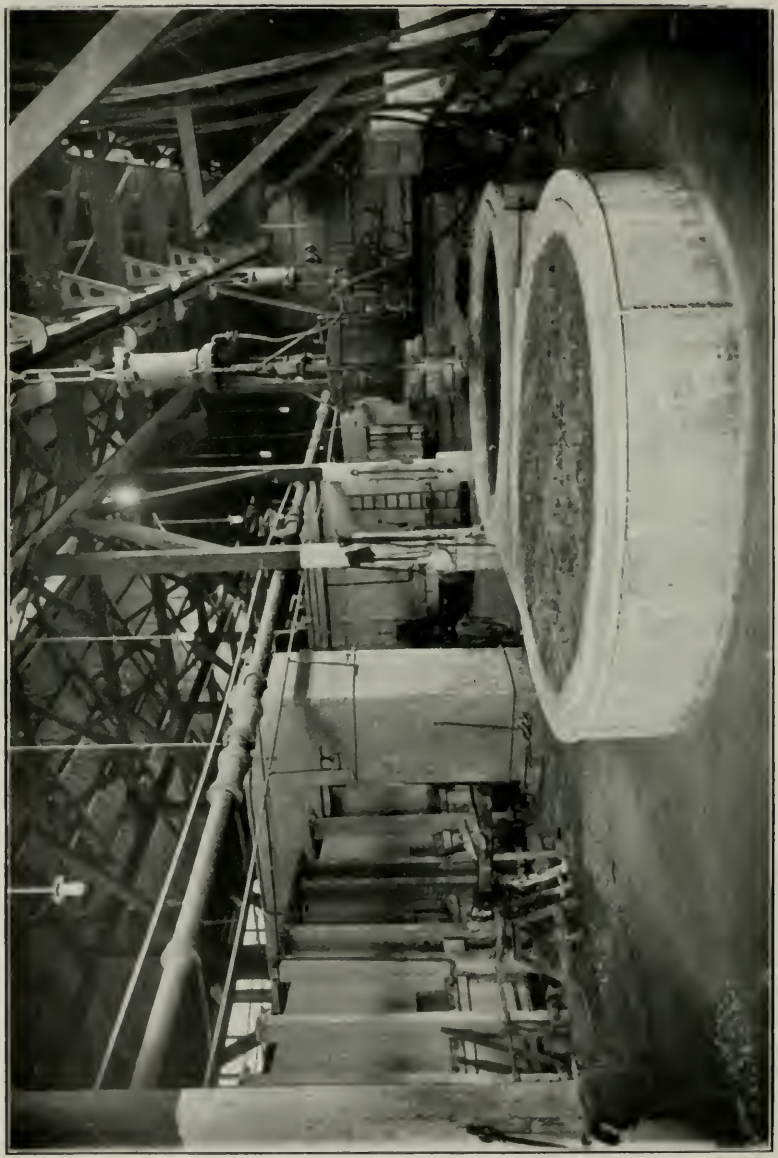


Fig. 1.
Section of Refinery.

The 44-ton desilverizing kettles and 38-ton market kettles are handled on special runways, centred over their respective kettle settings. These runways are carried on two 14-in. x 7-in. Oregon beams supported on C.I. brackets and, spiked to these 14-in. x 7-in. beams, are the rails which carry a ball-bearing crawl. To this crawl is suspended a tackle, from which are hung slings to lift the kettles. The travelling of these is done by hand, but is easily operated by one man. Ordinarily, these crawls are used to hang and travel the Howard presses and stirrers.

There are three working-floor levels in this building: No. 1, on the dump level, known as the cupel refiner parting room and firing-floor level; No. 2, on a level 3 ft. 6 in. lower than this, known as the moulding and soft lead storage floor; and the other, No. 3 floor, being elevated 7 ft. above the No. 1 or refiner floor. This elevated floor is known as the top floor, and is the one from which the melting kettles, softeners, desilverizing kettles, &c., are worked. This floor is built in reinforced concrete, with indented bar reinforcement. It is designed to carry 12½ cwt. per super. ft., having

Top Floor showing 5-ton Crane, Melting Kettles and Antimony Softeners.



Desilverizing Kettles and Howard Presses.

12-in. x 12-in. columns on 3-ft. 6-in. sq. footings. The beams are 24 in. x 12 in. up to 27 in. x 15 in., according to span. The floor proper has a total thickness of 9 in., 8 in. of this being 4–2–1 mixture, the other inch being a specially finished floating coat, laid while the main body was still plastic.

The advantage of the elevated floor is, that it allows a more perfect ventilation for the men engaged working on the No. 1 floor level, and also provides storage space for the various material used in connection with the operations. It also allows easy access from one end of the building to the other.

The various furnaces are connected to three stacks of similar construction through the three main parallel flues running underground.

The base bullion, after being drossed and moulded (25 bars per ton) at the smelters, is run on trucks via a low-level railway, direct to No. 1 electric crane, slung and hoisted in two-ton lots to the copper-drossing kettles. The bars are charged into the kettle, melted at a low temperature, and the copper dross skimmed. This dross is treated in a small liquating furnace, and the liquated bullion returned to the refinery, the copper dross going to the smelters. The molten metal in the copper-drossing kettle is then transferred to the antimony softener by means of a direct-coupled electrically-driven Rumsey centrifugal pump. These pumps are an innovation in Australian refinery practice. The pump is permanently fixed in a frame, which rests on the circumference of the kettle, and so arranged that, when in position, the pump is immersed to the full depth of the kettle (the casing is provided with spacing studs to keep it from actually resting on the bottom).

The time of pumping 40 tons is twenty minutes.

The antimony softener is the usual reverberatory type, water-jacketed, and lined with magnesite bricks at the litharge level; the end jacket is centrally channelled, the channel leading into a removable inclined spout, carrying the litharge into portable slag pots. After charging, the furnace is strongly fired, giving an oxidizing atmosphere, the resultant litharge being constantly run off at the channel and acting as a vehicle for carrying off the antimony and arsenic.

Towards the end of the operation the furnace is allowed to cool back, and the crust of litharge is skimmed by hand. The further treatment of the antimony and arsenic dross will be referred to later.

The operation takes, according to the antimony and arsenic contents, from eight to twelve hours, from time of charging to time of discharging into the desilverizing pans.

When "clean" the metal is tapped into one of two desilverizing pans, and the gold and silver separated by the Parkes process. No attempt is made to separate the gold and silver in the crusts, the whole alloy being mixed and retorted. The gold and silver contents are very variable, but only two zincings are made.

The spelter is added in cakes, melted on the surface and stirred in mechanically by means of the Howard rope-driven stirrer. The first zinc alloy is pressed off by the Howard press, which is worked by pneumatic pressure, and conveniently handled by an air hoist supported by a carriage on overhead runway. The second zincing is skimmed by hand. The pressed alloy goes direct to the retorts.

The desilverized lead is then syphoned to the refiner (usual reverberatory jacketed type) on the lower floor, and the zinc and any remaining antimony removed as a dross by skimming. The refined lead then passes by gravity to the market kettle, from which it is syphoned into a pot and runner, and moulded in a semicircular rake of hundredweight moulds, further skimmed and trimmed, weighed, stacked by means of a three-ton electric crane, and is then ready for shipment.

The skimmings from the antimony softener are stacked, and treated periodically in the antimony dross furnace ; a furnace with refractory lining, but no water-jackets. The material is charged in 3000-lb. lots, mixed with sufficient fine coal to reduce the bulk of the metal, the antimony and arsenic remaining in the slag. The slag and metal are periodically run off, the former into a bed, the latter into a five-ton kettle, from which it is moulded into bars and returned to the copper-drossing kettles. The slag, when cold, is broken up and further treated in a small blast furnace, the metal carrying the antimony and a trace of

arsenic. This antimonial lead is finely melted in a kettle and

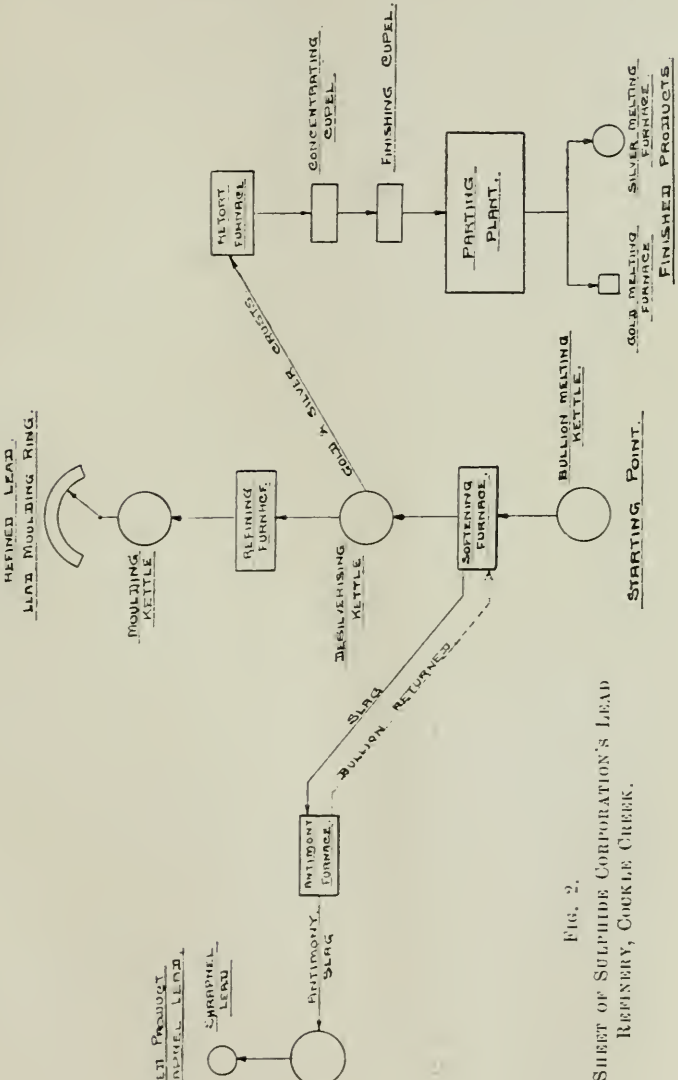


FIG. 2.

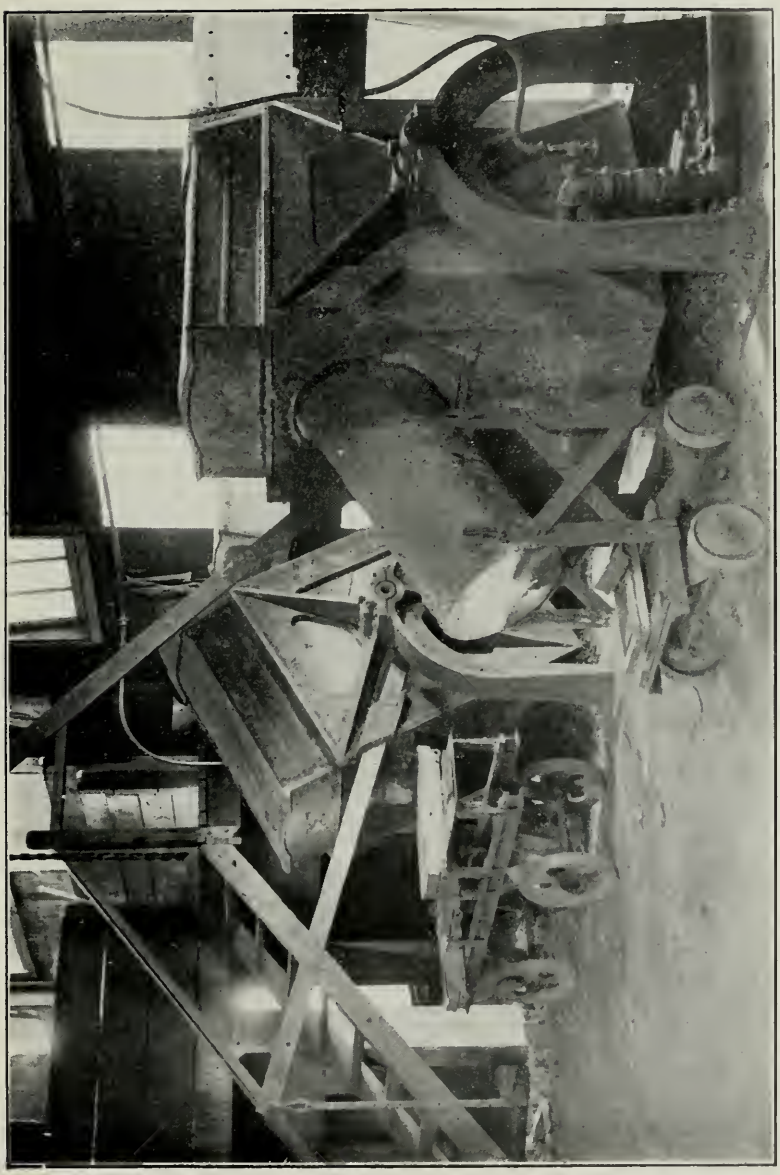
FLOW SHEET OF SULPHIDE CORPORATION'S LEAD REFINERY, COCKLE CREEK.

the antimony percentage reduced by dilution with refined lead to the requisite quantity for marketable shrapnel lead, and moulded into dumpy hundredweight bars.

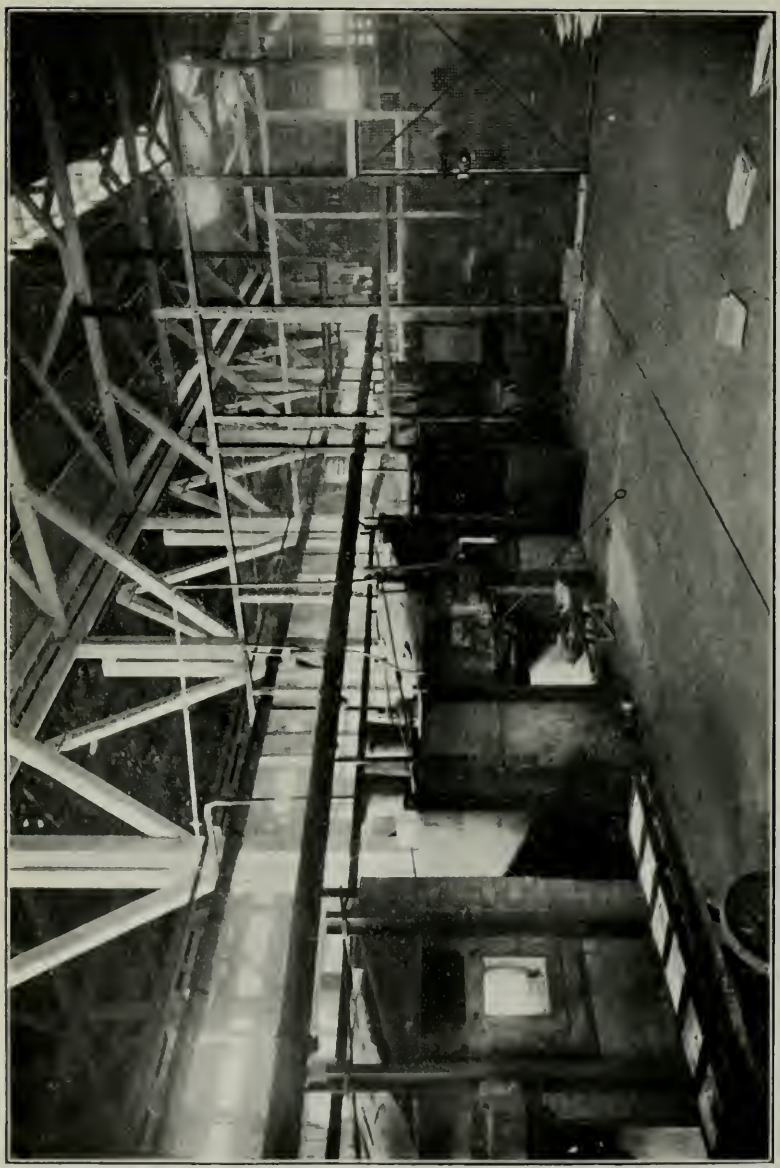
Returning to the pressed silver–zinc alloy from the desilverizing kettles, we find that this is charged in 12-cwt. lots to the inclined bottles of the gas-fired retort furnace, the zinc distilled and condensed, and the retorted bullion ladled into moulds.

The two tilting retort furnaces are a special feature of the plant, and are worked by one attendant. Each furnace is supplied with a low-pressure burner using oil from the Mond gas plant. This oil, which is also used in the gold and silver melting furnaces, is a heavy distillate from the tar, and has proved very efficient. The amount of oil used is 26 gal. per shift of eight hours. One charge of 10-cwt. alloy is finished each shift. The retorted bullion from the tilting furnace is lower in zinc than that from the gas-fired retorts. The life of the retorts in the tilting furnaces is very good, and for simplicity of operation the furnaces are a great success. When ready, the molten metal, instead of being ladled as in the case of the ordinary retort, is poured by tilting the furnace direct into moulds placed at the requisite height on a stepped portable frame. The retorted bullion (assaying 2000 to 2500 oz. Ag per ton) passes to the concentrating cupels, where it is worked up to "concentrated bullion," the lead passing off as litharge, which is granulated in water, the final alloy containing approximately 16,000 oz. silver and gold per ton. The charge held by the cupel or "test" increases with use from 10 cwt. to 14 cwt. The concentrated metal is ladled into moulds and transferred to the "finishing cupel." Here it is worked up to Doré, which may undergo a further transference to a "drying cupel," that removes the last traces of lead by absorption. The pure Doré is then ready for moulding for the parting operation into anodes; these are rectangular plates about $\frac{1}{4}$-in. thick, weighing approximately 100 oz.

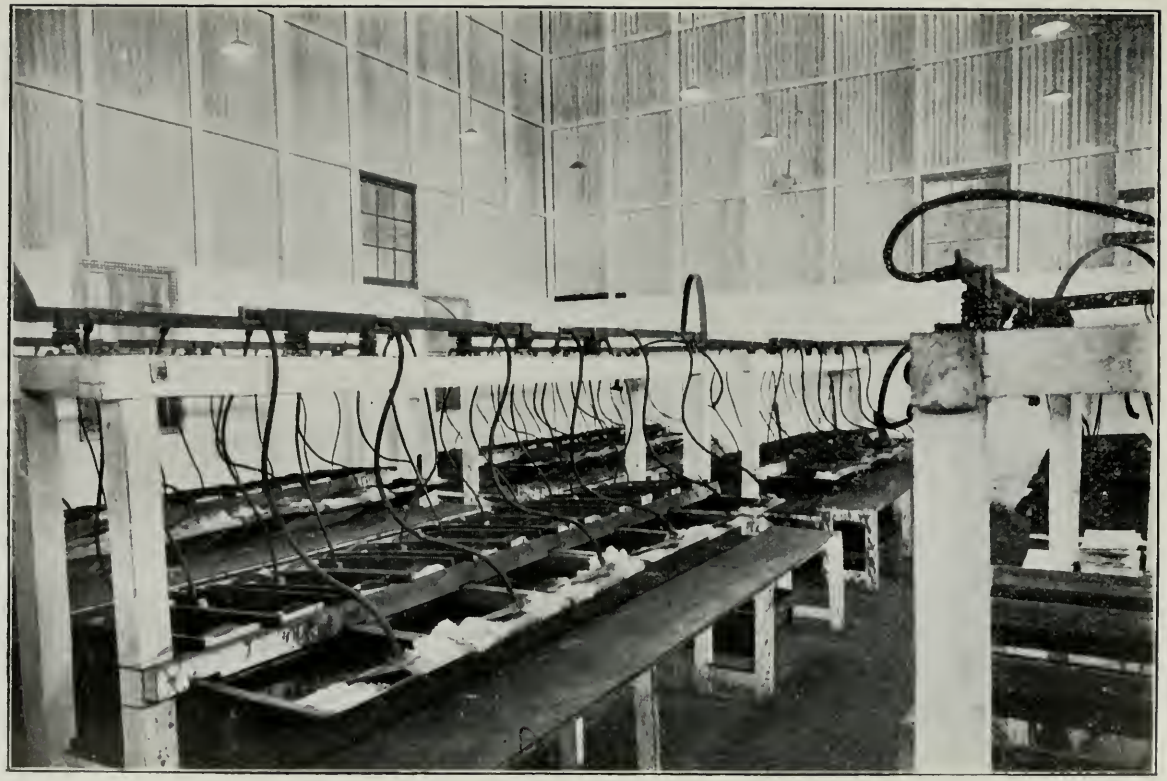
The electrolytic parting plant is furnished with 36 earthenware cells of the Balbach type. Each cell contains two wooden paraffined cradles with inner frames, holding the cloths (10-oz.



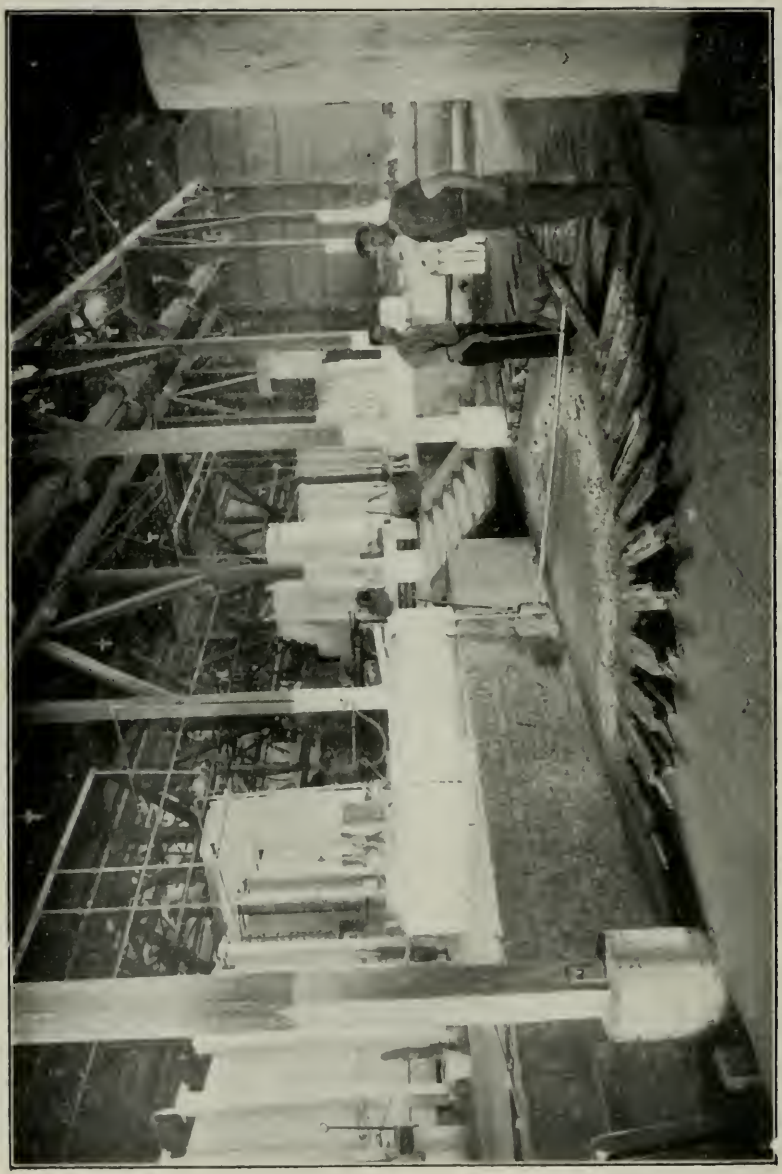
Oil-fired Tilting Retorts.



Cupels.



Parting Room.



Lead-Moulding Ring

linen duck). The anodes lie horizontally on the cloth, and are just immersed in the electrolyte. The electrolyte is essentially a solution of silver nitrate carrying as impurities a small quantity of lead nitrate and a considerable amount of copper nitrate. The solution is slightly acid, usually about 3 grm. per litre of free nitric. The current is passed to the anode by means of a "contact" piece (usually of pure Ag), and the silver deposited as pure crystalline metal on the carbon cathodes, which lie on the bottom of the cell. The silver is raked forward periodically and drained on the lip of the cell, withdrawn, washed in a separate wooden vessel, and stored loose in draining boxes. When comparatively dry it is bagged in very light calico bags, charged to a Morgan tilting furnace, and run into bars of 1050 oz. The gold remains as a sludge on the cloths. This is dried, inquarted with three times its weight of silver, and re-parted to give a denser product. Any remaining silver is dissolved by boiling with concentrated sulphuric acid, the gold washed free of silver, and melted in a Rockwell oil-fired furnace into bars of about 600 oz. The silver is remarkably pure, assaying 999.9 fine, and carrying only traces to 4 dwt. of gold per ton.

All kettles and furnaces, with the exception of the retorts, are fired direct with coal, but later on, no doubt, these will be heated by means of Mond gas. At present, however, the supply is not available, and it is impossible to build further producers until the supply of steel plates becomes more plentiful.

DESCRIPTION OF THE MOND BY-PRODUCT GAS PLANT.

By F. S. Sanderson.

The plant is one of the usual type of Mond plants, and contains no new features worthy of comment. A brief description of the process, however, with a few remarks on the working of the plant, may prove of interest.

Producer gas is made by passing a mixture of air and steam through incandescent carbon contained in a furnace called a producer, which, in the Mond type, is a cylindrical casing of steel plate, lined with firebrick, and fitted at the lower end with sloping fire-bars. Coal crushed to an even size (about 2-in. gauge) is elevated to bunkers over the producers, from which it is fed into a measuring hopper on each producer.

The hopper is a cast-iron cylinder fitted with a swing cover at the top and a bell valve at the bottom, worked by a lever and balance weight. When a charge of coal is run from the bunker into the hopper, the cover is closed, and the bell valve is lowered, allowing the coal contents to drop into the producer. Thus no gas can escape from, or air be admitted to, the producer during the process of charging. The hopper discharges its coal through a steel pipe-shaped container called the bell, which projects about 9 in. through the roof of the producer. The function of the bell is to spread the coal evenly over the fire, and supply coal to any portion of the fire as it settles.

The cover of the producer is provided with a number of poking holes (sealed with balls when not being used) through which the fire is frequently poked to prevent the formation of "pipes" in the fuel bed through which air could pass, and so dilute the gas. Poke-holes are also fitted in the casing opposite the fire-bars for the purpose of breaking up any clinker that might form, and also to work down the ashes through the bars.

The bottom of the producer is open, and is supported in a pit filled with water, forming a water seal of sufficient depth to prevent the escape of the air blast, and also to act as a safety vent, should an explosion of the gases occur inside the producer. The

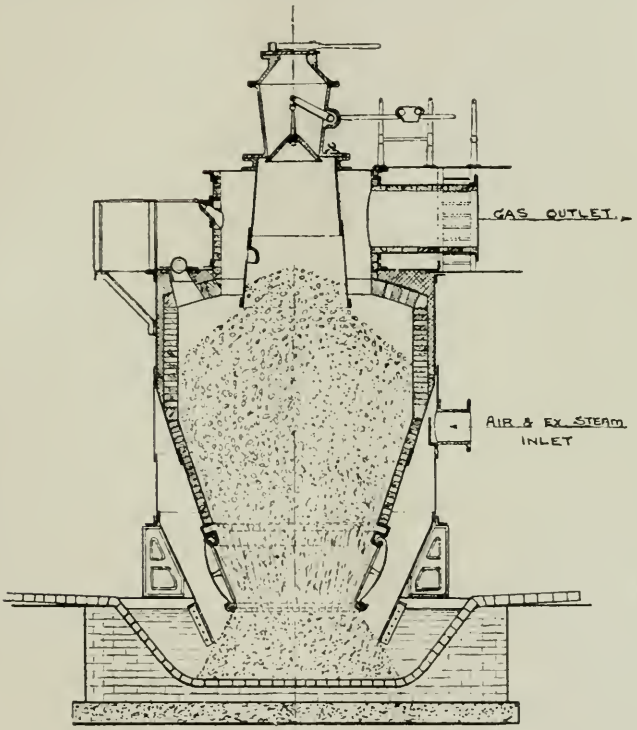


FIG. 3.

DIAGRAM SHOWING MOND PRODUCER.

ashes work down the sloping bars into the pit, and are withdrawn, by means of a long-handled shovel, evenly all round the pit while the producer is working.

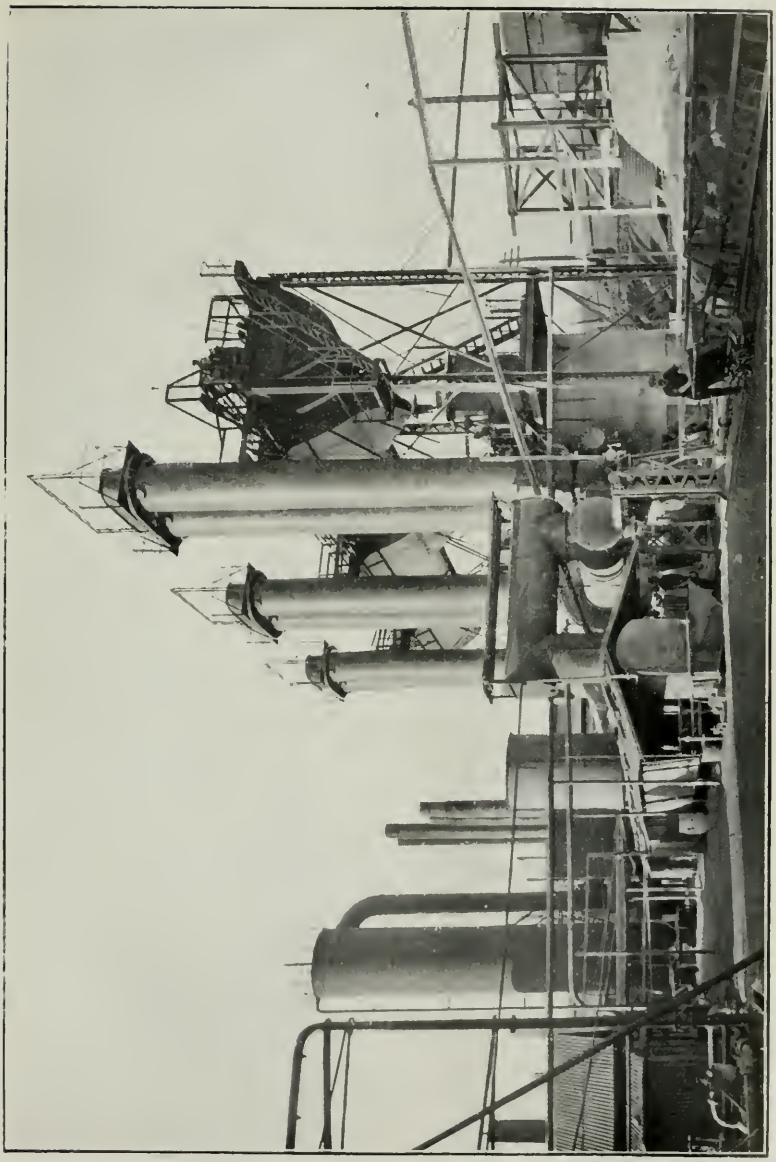
Exhaust steam from the generating station, and air from a Roots blower, are mixed in fixed proportions, and forced through superheaters into the space underneath the grate. The tem-

perature of the aqueous vapour at the grate is about 190° C. After passing through the bars, the mixture meets the incandescent carbon, where the oxygen in the air and part of the oxygen in the steam combines with the carbon to form CO_2. Higher up in the furnace the steam is decomposed, and the temperature of the fire reduced, with the result that part of the CO_2 is reduced to CO. This, with hydrogen from the decomposed steam, mixes with volatile gases given off by the coal at the top portion of the producer. The effect of the steam is also to prevent clinkering, and to keep the temperature low enough to prevent any ammonia formed from being again split up, which would be the case if the producer were worked with a hot top. When the gases leave the producer they pass through a superheater, which is a large vertical steel casing surrounding an internal tube.

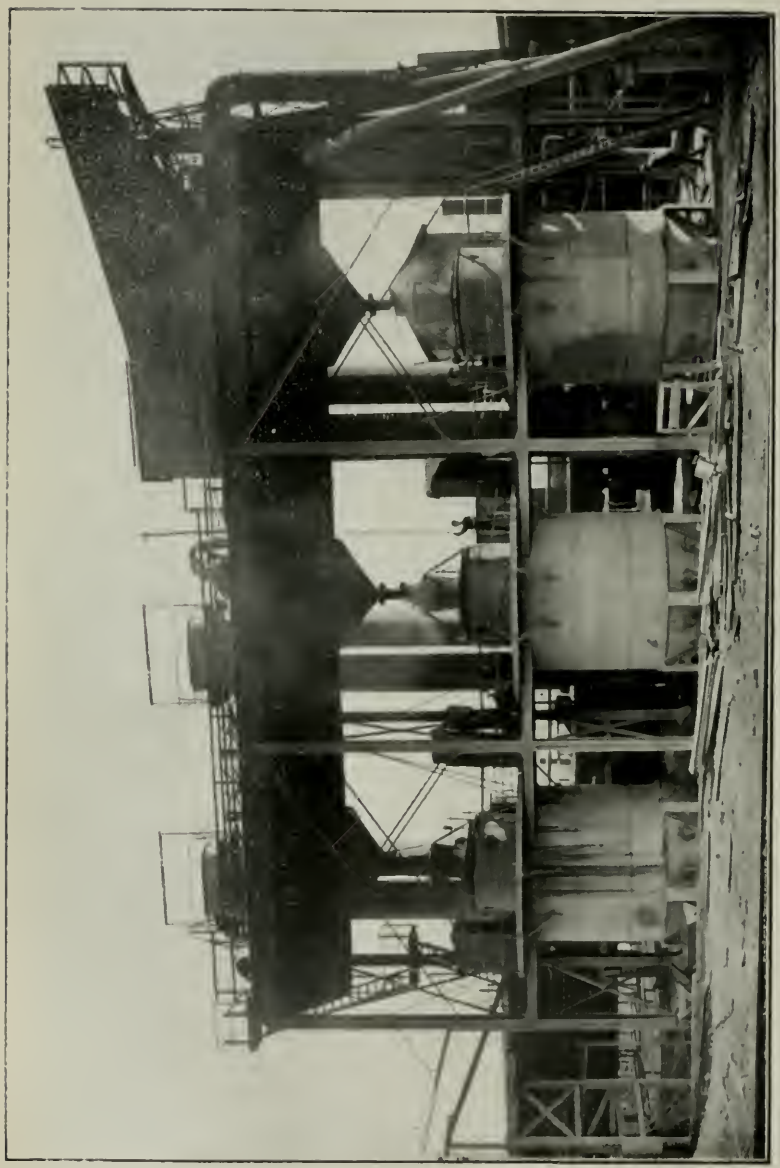
The air and steam, as already mentioned, pass into the casing and absorb heat from the hot outward gases passing through the tubes. Thus the air blast is heated, and the gases partially cooled. The gases pass from the superheater into a long rectangular chamber, called the washer, containing water which is sprayed up by revolving paddles or dashers, cooling the gas to a great extent, and removing the dust and portion of the tar. The gas then goes into a similar chamber, called the absorber, containing a $1\frac{1}{2}$ % sulphuric acid solution. This solution is sprayed through the gas by dashers, and absorbs the ammonia in the gas, forming a weak solution of ammonium sulphate. Fresh acid of 1.5 sp. gr. is constantly added to maintain the strength of the liquor.

Both the washer and the absorber are fitted with a cleaning lute, from which a large proportion of the tar is recovered and sent to the tar-distillation plant.

The gas passes from the absorber to the foot of a tall cooling tower, built from steel plate and packed with earthenware rings. The tower is closed at the top, and water-sealed at the bottom. The gas on its way up the tower meets a spray of water which cools the gas, thus removing any surplus water-vapour which would dilute the gas. A further quantity of tar is recovered here. The tar is collected in the tank at the base of the tower, and blown



Mond Gas Plant showing Producers Absorbers and Gas-cooling Towers.



Mond Producers, Coal Elevator and Bunker.

over to the tar plant by compressed air. The warm water from the base of the tower is pumped over a wooden cooling tower, where it is cooled and used over again. The gas now goes through the distributing mains to the boilers and roasting furnaces.

The sulphate of ammonia solution, when it reaches 40° T.W., gravitates into lead storage vats, from which it is pumped to a vacuum evaporator heated by steam. After boiling for a certain time, the sulphate of ammonia crystallizes out, and is discharged into a centrifugal hydro extractor, which frees it from any remaining moisture. The sulphate is now bagged and weighed, and is ready for the market.

The coal for this type of producer must be non-coking, and the only coals of this description in the district are very high in ash contents. The following is the composition of the coal at present being used :—

Moisture	2.59 %
Volatile matter	24.75 %
Fixed carbon	51.45 %
Nitrogen	1.1 %
Ash	16 % to 22 %
Calorific value	11,694 B.Th.U.

The coal must be crushed to an even size, and contain as little dust as possible. The bell should be kept full of coal, and the fire maintained at a certain height. The fire should have a blackish appearance when viewed through a poke-hole, and the gas escaping from an open poke-hole should show no signs of redness.

Fluctuations in the demand for gas, and variations in the temperature of the atmosphere, affect the working of the producers. "Forcing" the producers, owing to the increased temperature of the gases, greatly reduces the recovery of sulphate of ammonia. For normal working—i.e., to produce a suitable gas, and also obtain a good recovery of ammonia—it is necessary to keep the temperature of the blast between 83° and 85° C. With the normal pressure of 40 cm. water-gauge pressure at the blowers, the pressure of the gas in the supply main should be 5 cm. Two tons of steam are required per ton of coal burnt, and each producer requires about 800 cub. ft. of air per minute.

The gas leaving the cooling tower was formerly cooled to 35° C., but, at this temperature, the tar clogs up the packing in the tower, and blocks up the "tar drips" and valves in the distributing mains. The outward gas is now kept at 40° C., at which temperature the tar runs freely. For this purpose, about 2000 gal. per min. of fresh water for cooling are circulated in this operation, and the amount to be made up per day for loss by evaporation is 3000 gal. Salt water from Cockle Creek is used as cooling water in the condenser for obtaining the vacuum in the evaporator, where about 40,000 gal. per day are required.

The plant treats from 65 to 70 tons of coal per day, for an output of 122,000 cub. ft. of gas per ton of coal, having a calorific value of 135 B.Th.U. per cub. ft., and having the following analysis by volume :—

CO_2	..	..	15.8 %
CO	..	..	15 %
H	..	..	26 %

The by-products average 75 lb. sulphate ammonia per ton of coal, and 8 gal. of anhydrous tar. The process being a low-temperature one, the tar belongs to the paraffinoid order, and does not contain any benzene, toluene, xylene, naphthalene, and anthracene, but contains phenols of the higher orders, members of the paraffine series, and others closely related to it.

The gas is at present being used to fire the mechanical roasting furnaces at the lead-smelting plant, and also to fire two Babcock boilers at the generating station.

The gas has been found most suitable for all work for which it has been supplied, and will in the future, no doubt, be largely extended. The temperature of the roasting furnaces is easily controlled, and there is now none of the loss of heat that formerly took place while the coal fires were being cleaned. The gas-firing of the boilers has been very successful, the heat being well distributed around all the tubes; this has greatly added to the life of the tubes, and also increased the amount of water evaporated.

The ammonium sulphate has a good crystalline appearance, and contains 25 % of NH_3.

SHORT DESCRIPTION OF THE TAR-DISTILLATION PLANT.

By A. Gatley Lyon.

Mond gas-producer tar, and, in fact, all tars obtained from the retorting of coal where steam and air are admitted to the retort, are of entirely different chemical composition to the ordinary coal tar made in the gas or coke works.

These tars contain none of the aromatic hydrocarbons—benzene, toluene, naphthalene, and anthracene, sought after by the ordinary coal-tar refiner.

The distillation of Mond tar shows it to consist of phenols of high molecular weight, unsaturated hydrocarbons of high gravity and low viscosity, paraffin wax, and resinous substances of whose composition little is known.

The physical properties of Mond producer tar are also peculiar. It has a "short," granular texture when cold, which might be likened to candied honey. It "dries" (hardens) when exposed in thin layers to the air, and, for a coal tar, it cannot be considered sticky. This latter property, combined with the short texture, prevents its being used successfully for road-making or macadamizing. The drying properties and the paraffin wax contained in this tar cause it to hold up large percentages of water, probably in the form of emulsion. When containing as much as 10 % to 15 % moisture it appears to be quite dry.

The tar is received from the gas plant into a large boiler shell, used as a tar-storage tank, in which the tar is kept hot by means of steam coils. A considerable amount of water separates in this tank, and is drawn off from the surface of the tar by means of a Dutch syphon. This syphon is made by bolting a pair of screwed flanges into the bottom of the tank, attaching two pipe elbows, and a length of piping inside, long enough to reach to the top of the tank. The second of these elbows is loosely screwed so as to form a hinge on which the piping pivots. To the pipe is

attached a chain or rod, protruding through the roof of the tank, by means of which the pipe can be lowered or lifted at will. By this means the whole of the water can be withdrawn from the surface of the tar, no matter to what height the tank is filled. This syphon arrangement is fitted to each of the tar and oil-storage tanks.

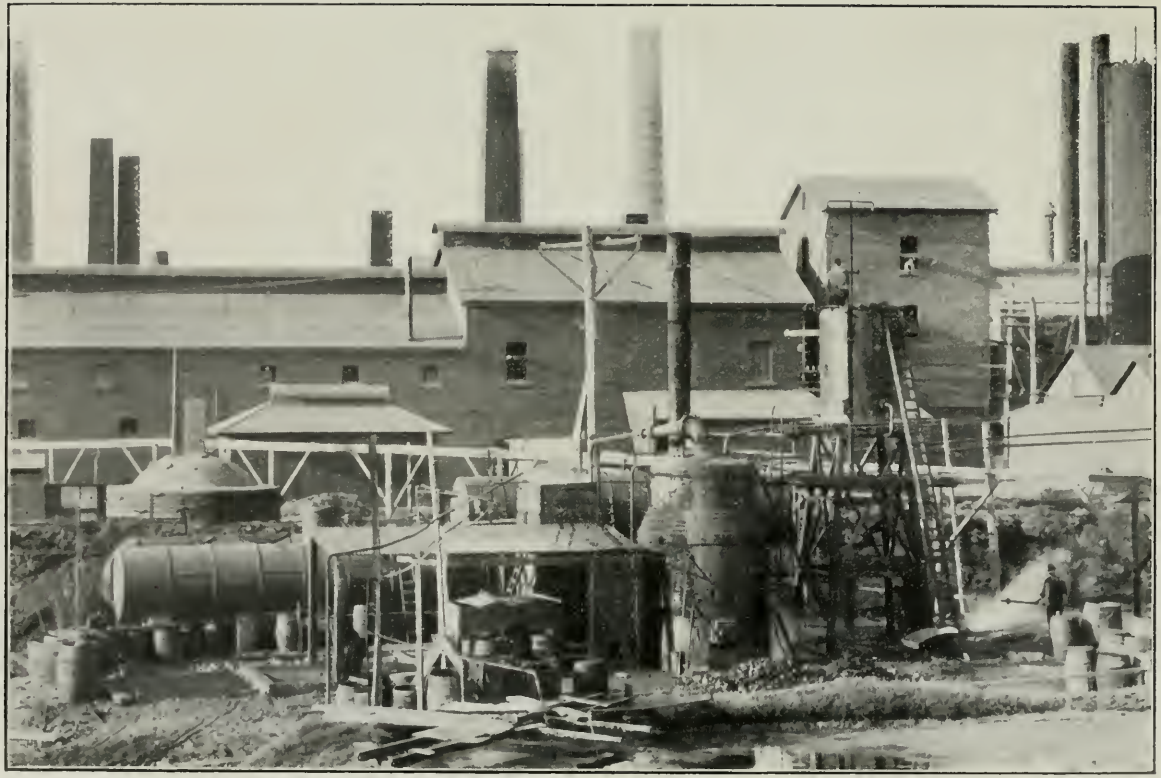
The tar is run from the bottom of the storage tank into a blower egg, from which it is elevated to the dehydrator. The dehydrator is a round tank about 5 ft. 6 in. diam. by 8 ft., liberally fitted with steam coils, an overflow pipe leading back to the storage tank, and a run-off pipe directly connected with the tar still. Great care has to be taken in dehydrating the tar, owing to its strong frothing tendencies. When the tar reaches a temperature of 120° C., it is considered safe to charge into the still.

The still, which is of orthodox design, 6 ft. diam. by 7 ft. 9 in. deep, with a concave bottom of 21-in. depression, holds a charge of 1000 gal. The mountings consist of the still head, man-hole door, safety valve, thermometer pocket, dipping cock (for measuring contents), steam and tar inlets. A few inches from the top of the side of the still is an overflow pipe, and at the bottom, protected from the fire by brickwork, is the pitch run-off cock.

It is found that the distillation of tar is materially accelerated when hot superheated steam is blown through the boiling tar. This steam not only assists mechanically in driving off the oil fumes, but causes the oils to distil at a lower temperature than they ordinarily would. This steam arrangement is made so that the steam passes through a 1½-in. hydraulic pipe, placed in the fire-box underneath the still, where it is superheated. It then passes through the top of the still and down into a distributing rose lying on the bottom of the still.

Directly connected with the still is a condenser, consisting of a vat containing a 2-in. iron-pipe worm, from which the oil, after condensing, runs into the storage tanks.

The still is charged with about 900 gal. of dehydrated tar, which is usually about 130° C. when leaving the dehydrator. A



Tar Still.

small fire is started until the oil begins to distil, usually at about 190° C. The fire is then gradually increased for about six or seven hours, the exact time depending on the specific gravity of the oil at the worm end. When the sp. gr. reaches the desired point, the fire is drawn, and superheated steam, which has been turned on soon after the distillation was well under way, is allowed to blow through the still for a further two hours, thereby driving off the remainder of the oil, and cooling the pitch. By the time the fire is drawn, the water in the condenser is almost up to boiling-point, and the distillate is a thick, sticky, semi-solid oil of a sp. gr. of 1.120.

All the oil has now been driven off from the tar, and the residual pitch is run off by opening the cock at the bottom of the still into a preliminary cooling tank, from where it is run into brick bays and allowed to set.

The pitch, for which there is at present only a limited market, is returned to the Mond gas producers, where it is consumed along with the coal, giving further quantities of tar, gas, and ammonia.

The oil is at present being all run for fuel oil, for use in the bullion refinery, but it is hoped in the near future to further refine this oil, with the object of making lubricating oils, grease, paraffin wax, &c.

THE COAL INDUSTRY OF NEW SOUTH WALES.

BY A. A. ATKINSON.

As it is probable that a large proportion of the members of the Institute attending this meeting are connected with the metalliferous side of mining, the writer thought that, as coal and coke are required for various purposes in considerable quantities by their companies, some particulars of the coal industry might be of interest, especially when visiting such an important coal-mining centre as Newcastle.

It is proposed to deal with the matter from the mining and economic point of view, as the geology has been so well and exhaustively dealt with in various publications referred to in the bibliography at the end of this paper.

In the immediate vicinity of the city of Newcastle the collieries are gradually being abandoned, and during the past few years the Wickham and Bullock Island, Stockton, Hetton, Newcastle Coal Mining Company's "B," and the Australian Agricultural Co.'s Sea pit, have disappeared from the coal-producing list of collieries.

All of these collieries worked the Borehole seam, from which, up to date, the largest quantity of coal has been produced in the northern district.

It is the bottom seam of any present commercial value in the Upper or Newcastle coal-measures, and although the coal in this seam has not been entirely exhausted in the collieries referred to, they have been abandoned for various reasons. For example, although about 60 % of the seam (18 to 20 ft. thick) was left in the workings in the form of rectangular pillars under the city of Newcastle, this was not sufficient to prevent the subsidence which took place about twelve years ago.

Again, large quantities of coal in the Borehole seam have been left to protect the shipping arrangements at the Dyke, and other

[This paper is separately bound, and may be if so desired, detached complete from this number.]

public works and buildings near the city ; and as the seam in this locality will average 15 ft. thick (yielding more than 20,000 tons per acre), it is obvious that, so far, it has been considered necessary to leave a very large quantity of this very fine coal underground.

Unfortunately, the coal in this seam under the Pacific Ocean has only been worked to a limited extent in the vicinity of Newcastle, owing to its proximity to the bed of the ocean, and the limit being placed on its being worked by the Department of Mines—viz., that there must be at least 120 ft. of good sound strata between the top of the coal worked and the bed of the ocean—this, and other regulations in regard to boreholes, width of underground drives, and pillars being considered essential in the interests of safety.

The regulation in regard to the limit of working resulted in the abandonment of operations in the coal under the ocean at the Stockton Colliery, the Australian Agricultural Company's Sea pit, the Newcastle Coal Mining Company's "A" and "B" pits, and the Dudley Colliery. In all of these workings the limit referred to above had been reached before they were stopped, whilst in the Hetton Colliery they had not far to go, when a decision was arrived at to cease operations, for other reasons.

In the latter colliery a large quantity of coal has been left under the Hunter River in pillars, at depths varying from 160 ft. to 250 ft., at its entry into the Pacific Ocean.

On the north side of the river, and in the Stockton peninsula, the dangerous character of the alluvial deposits overlying the Borehole seam had been referred to so long ago as 1886, on p. 67 of the third report of the Royal Commission on the condition of the collieries adjacent to Ferndale, and under the peninsula in the workings of the Stockton Colliery the alluvial deposits were found in places resting on the top of the Borehole coal seam.

It became obviously necessary, therefore, to prove the thickness of the alluvial deposits between the bed of the ocean and the coal seam in order to ascertain the thickness of reliable strata which could be depended upon to protect the workings, and to ensure the safety of those engaged below.

Consequently, the services of the officers of the Public Works Department were availed of, with a view to having some boreholes put down in the bed of the ocean, to prove the thickness of the alluvial deposits overlying the coal seam; and, although this work was very difficult to carry out, great credit was due to Messrs. W. J. Millner, G. H. Halligan, and C. King, district engineer, hydrographer, and assistant engineer respectively, for the manner in which it was performed.

No. 1 borehole proved that the alluvial deposits were at least 128½ ft. thick, but, owing to the difficult and unusual character of the work, it was found impossible to carry the borehole to a greater depth. After some further attempts in the ocean this work was abandoned, and it was decided between the management of the Stockton Colliery and the Department of Mines to put up a borehole from the seam in the most northerly workings then advancing under the ocean.

Before this work was commenced a pipe was securely fixed some distance into the strong sandstone above the coal, at the lower end of which a valve was placed. The whole apparatus was tested by means of a hydraulic pump to a pressure of 227 lb. to the square inch, and, as this was considered satisfactory, in view of any quantity or pressure of water that was likely to be encountered, the borehole was then started, with the result that at a point 80 ft. 7 in. above the top of the coal seam worked the bottom of the alluvial deposits was reached. The strata passed through in the borehole, before reaching the latter, consisted of the usual coal-measures, deposits of shale, sandstone, and conglomerate; and it is pertinent to remark here that there was no evidence of any clay, which is looked upon as a great safeguard in workings under large bodies of water.

In consequence of this the ocean-workings were abandoned, and in 1907 the Stockton Colliery ceased coal-getting operations.

The seam of coal where these operations were stopped varied in thickness from 8 to 9 ft., and was of very high quality. It was unfortunate that the overhead strata conditions did not admit of its being worked.

The approximate area of coal worked in the Borehole seam at the six collieries where operations under the ocean have ceased amounts to about 1000 acres, and at present there is only one colliery—viz., Burwood—working any of this coal.

It will be seen from these remarks that owing to the shallowness of the coal, little of the Borehole seam, and none from any other, is likely to be worked under the ocean near the mouth of the Hunter River.

It has been suggested that if sufficiently thick beds of clay, impervious to water, can be found under the river, it might be possible, by adopting the system of hydraulic sand-stowing, to remove some of the pillars with safety. This, however, is an operation likely to be left to a future generation, when coal becomes more difficult and costly to get than at present.

In consequence of the gradual closing of collieries near the city, it may be mentioned that the output in the year 1907 from collieries within a radius of three miles from the railway station was nearly one million tons, whereas last year it was only 94,000 tons. It is not surprising, therefore, that the old saying, "Carrying coals to Newcastle," is becoming a matter of fact in reference to "the Coaly City."

So far, the deep boreholes near to Newcastle, one of which was put down by the Australian Agricultural Company to a depth of 3000 ft., have not proved any seams of workable thickness below the Borehole seam, and as Professor David (now Major David, C.M.G.) estimates that the Greta seams below Newcastle are not likely to be found at less than from 8000 to 10,000 ft. in depth, there is little hope of any increase of mining operations near the city.

With these preliminary remarks, particularly pertinent to the immediate neighbourhood, the writer proposes now to deal with the subject of coal-mining generally, as carried on in New South Wales.

Output per Person.

PERSONS EMPLOYED, AND ACCIDENTS IN CONNECTION WITH COAL MINING.

During last year (1917) there were 19,197 persons employed in and about the collieries. Of these, 12,701, or 73.86 %, were engaged underground, and 4496, or 26.14 %, were surface employés.

The output of coal per underground and surface employé was as follows in the respective districts :—

Northern	.. 465	
Southern	.. 448 - 482	tons.
Western	.. 710	

In Great Britain, in 1912, the corresponding figure was 251 tons per person employed below and above ground.

During the twenty years ending with 1916, 456 deaths resulted from accidents in and about coal mines. The mineral raised per each life lost during the above period was 410,217 tons, or, put in another way, the death-rate per million tons raised was 3.069. The corresponding figure for Great Britain in 1912 was 4.67.

The accident death-rate in collieries compares very favourably with those of other coal-mining countries, although the period given above includes the explosions at Dudley Colliery in 1898 and Mount Kembla in 1902, when 15 and 95 lives were lost respectively.

It is very satisfactory to record that since 1906 no lives have been lost as the result of explosions of firedamp or coal dust.

The percentages of deaths due to various causes, the results of accidents during the past 20 years, were as follows :—

	%
Explosions of firedamp or coal dust	26.1
Falls of roof and sides	38.1
In shafts	3.1
Miscellaneous underground	20.6
Total underground	87.9
,, on surface	12.1
	100.0

Methods of Working.

The most generally adopted method of working is the "bord and pillar" or "stoop and room." This consists of removing a certain percentage of the seam by driving galleries known as bords, headings, and cut-throughs, varying in width from about 4 to 12 yds., and leaving rectangular pillars for temporary support, but which are often subsequently recovered in a future second or pillar-working.

In Crown coal leases, the proportion of coal to constitute these pillars is regulated according to the depth from the surface, with a view to ensure as far as possible sufficient support to prevent the superincumbent strata bringing about a crush, or "creep," and a subsequent great loss of coal.

The other method of working consists of removing all the coal as the workings advance, the hauling and ventilating roads being secured by means of stone pack walls through the goaf or gob. This is known as the "longwall" system, and it has only been adopted to a very limited extent in New South Wales, and in comparatively thin seams. It has proved satisfactory at the Sydney Harbour Colliery, with a seam up to 7 ft. thick, at a depth of 2900 ft.

In consequence of the liability of some seams of coal to spontaneous combustion, it is necessary to form areas or panels of pillars in such a way as to facilitate the sealing-off of these areas, by means of brick walls or stoppings to cut off the air, in the event of incipient combustion making its appearance.

This trouble is most common in the Greta seams, and in some collieries of the Maitland district the adoption of the panel system has been so well attended to that, although it has been necessary to seal-off districts from time to time, this has been done successfully, and without affecting any other parts of the workings.

Although there have been instances of spontaneous combustion in some of the other seams of the Northern district, it is more particularly confined to the Greta seams. Fortunately, this trouble has not yet made its appearance in the collieries in the Western and Southern districts.

Where the top seam of the Greta measures reaches a great thickness, as, for instance, up to 30 ft. in some of the collieries

in the vicinity of Cessnock, it is a problem of considerable importance as to how to work the seam with the least possible loss of coal, and this is a matter which receives a great deal of consideration from the officers of the Department of Mines and colliery managers.

The following is a section of this seam at Aberdare Central colliery :—

Roof—sandstone, with coal pipes.	ft.	in.
Coal	0	4
Clay parting	0	1½
Coal—fair quality	3	9
Splinty coal	0	6½
Good coal	3	4½
Stone band	0	2
Coal—fair quality	0	6
Stone band	0	5
Good coal	7	3
Clay band	0	1
Good coal	14	0
	30	6½

The seam is therefore made up of—

	ft.	in.
Good coal	24	7½
Coal—fair quality	4	3
Splinty coal	0	6½
Coal—doubtful as to quality ..	0	4
Bands of stone	0	9½
	30	6½

It will be seen that the upper portion of the seam contains some coal described as of fair quality, together with 6½ in. of splinty coal and 9½ in. of stone bands. This part of the seam also usually includes what is locally known as the "brassy tops," which is regarded as the most dangerous part of the seam, because when it falls and is exposed to the atmosphere it frequently causes spontaneous combustion. It contains sulphide of iron ($Fe\ S_2$) in the form of pyrites and marcasite, the latter of which is very unstable, and readily decomposes, oxidizes, and causes spontaneous combustion.

For the above reasons, and because the bottom portion of the seam contains the best coal, it is worked first.

This is usually done in two layers of 7, 8, or 9 ft. each, according to the partings in the seam. The bottom portion is worked first, the second or "tops" being dropped afterwards, either by the retreating or advancing method.

The hydraulic method of stowing the workings of thick seams in order to win the largest possible percentage of coal has been tried with considerable success in other countries, but this necessitates a large available supply of sand or other similar material, and this condition does not exist on the Maitland coal field. This method, where it is adopted, has also the advantage of considerably reducing the liability to spontaneous combustion, which is an important factor.

Although this seam lies comparatively flat, its thickness is such that it may, in some measure, be likened to a big metalliferous lode, and the hydraulic method of stowing or filling will probably appeal to many mining engineers, members of this Institute, as well worth a trial; but it must be remembered that the coal being dealt with is only worth shillings per ton, whilst the ore in the metal mine is probably worth as many pounds per ton.

The difficulty of recovering a reasonably large percentage of coal from a seam, provided that the workings are properly laid out, having regard to the depth and other conditions, only arises in the case of very thick seams, and this trouble is therefore almost confined to the Maitland–Greta–Cessnock coal-field.

Removal of Coal from its Bed.

The removal of coal from its bed or seam is effected by hand-holing with picks, or by aid of coal-cutting machines, usually operated by means of electrical power, but occasionally with compressed air. After the coal is undercut or holed, it is usually blasted with gunpowder or a permitted explosive.

The following table taken from the report of the Chief Inspector of Coal Mines for 1917 gives particulars of the classes of machines used, the operating power, and the quantity of coal cut:—

PARTICULARS OF COAL CUT BY MACHINERY IN NEW SOUTH WALES DURING THE YEARS 1916 AND 1917.

Year.	Class of Machine.					Motive power.		Tons of Mineral Obtained.		
	Disc.	Percussive.	Revolving bar.	Chain-breast.	Total.	Electricity.	Compressed Air.	By Electricity.	By Compressed Air.	Total.
								tons.	tons.	tons.
1917 ..	—	94	—	179	273	179	94	1,822,897	486,289	2,309,186
1916	—	139	1	172	312	173	139	1,797,066	653,205	2,450,271
Increase ..	—	—	—	7	—	6	—	25,831	—	—
Decrease ..	—	45	1	—	39	—	45	—	166,916	141.085

The only large installation of coal-cutting machines operated by means of compressed air is at the Pelaw Main and the Richmond Main collieries, where percussive machines of the Ingersoll type are used.

Other machines of this type, such as the Siskol and Little Hardy, are used to a limited extent for driving winning and narrow places at a few collieries, but they are not so much favoured as electrically-driven machines where that power can be safely used.

The miners do not show so much objection to the coal-cutting machines now as in the early days of their use. This is fortunate, as the coal is got with much less danger than with hand-holing, and the miner is relieved of the latter hard work, and at the same time makes fair wages.

Machines to load the coal into the tubs in the working places have not yet been introduced, but they have been used to a limited extent in the United States of America.

Shafts, Tunnels, and Depths at which Coal is Worked.

The greatest depth at which coal-mining has been carried on was at the Sydney Harbour Colliery (at present not working), at about 2900 ft.; apart from that, no coal is being won at a depth exceeding 1500 ft.

Circular shafts up to 22 ft. in diameter are usually sunk in the colliery districts, and in many cases they are lined with bricks

from the surface to the coal seam, as the strata are liable to give trouble by weathering if not protected.

About two-thirds of the output of coal is at present won by means of tunnels or drifts, and one-third from shafts.

Ventilation.

Ventilation is produced at nearly all the large collieries by means of exhaust fans, which are much more efficient than furnaces, especially when the shafts are shallow.

According to the figures given by the colliery managers, taking the six largest quantities of air circulated, they vary from 210,000 to 450,000 cub. ft. of air per minute—and all ventilated by means of fans.

In two collieries, underground "booster" fans have been used with a certain measure of success, although it is difficult to prevent an amount of "churning," or local circulation of air, which militates against the efficiency of these fans.

For ventilating advance headings or prospecting places, small blower fans, electrically driven, are frequently used with considerable success, and, being portable, are very convenient for removal from place to place.

Lighting of Mines Underground.

In nearly all the large collieries electric light is installed underground, the lights being principally used at the shaft bottoms, engine landings, and other important points.

According to the return facing page 56, there were 2134, 1123, and 134 of these lights used underground in the collieries of the Northern, Southern, and Western districts respectively.

In the naked-light collieries, the workmen generally use what is known as the Scotch oil lamp, which they attach to the front of their caps when they are moving about.

In those collieries or parts of collieries where the use of naked lights is not allowed, various types of oil safety lamps are used. Electric safety lamps have been tried at a few collieries, but their adoption does not increase, as, on account of the war, it is difficult to get the necessary parts.

The only colliery where they are used to any extent at the present time is South Bulli, on the South Coast.

Water and Pumping Arrangements.

As a rule, the collieries of New South Wales are not troubled with much water.

At present there is no colliery with feeders of water amounting to 300 gal. per minute. The Delta collieries, Stockton and Hetton, have had the largest quantities of water to deal with, but even when Stockton had been abandoned, and Hetton was pumping the feeders of both collieries, this did not amount to more than about 48,000 gal. per hour, or 800 gal. per minute.

All the water is dealt with by pumps placed near the bottom of the shafts or tunnels, and in the workings. The motive power is steam or electricity in the former case, and electricity or compressed air in the workings.

There is no instance of pumping by means of heavy spears operated with beams or quadrants, driven by large engines on the surface—a type of installation which was very common in some countries years ago, but which is gradually being replaced by underground installations.

The application of electricity to pumping water, especially from more distant workings, has been found to be a great convenience, and, although there is some loss in transmission, it is negligible as compared with that when steam or compressed air is used.

In sinking shafts it is seldom that as much as 6000 gal. of water per hour has to be dealt with, and, generally speaking, pumps are not required, the sinking bucket being used to raise the water until a permanent pumping plant has been installed.

In the Maitland district the shafts are usually dry until the coal is reached—in fact, it was necessary to send water down some of the shafts for tamping purposes in connection with shot-firing during sinking operations.

Haulage.

The haulage of the coal from the working places is effected by means of—

(*a*) Horses and ponies.

(*b*) Mechanical haulage operated by means of steam, electricity, or compressed air.

(*c*) Self-acting inclines.

(*a*) Horses and ponies are used to haul the coal between the working places and the engine landings. They are usually from 12 to 16 hands high, and in the large collieries up to 80 or 90 are employed.

For economical working it is desirable to keep the engine-power operating as near the faces as possible, for each horse and its driver will cost from £100 to £300 per annum.

(*b*) Mechanical haulage operated by steam, electricity, or compressed air. The systems of haulage are known as the Main Rope, Main and Tail Rope, and Endless Rope.

In the former, which can only be used when the gradient is against the load, the empty tubs draw the rope into the mine, and engine-power hauls the full load only.

With the Main and Tail Rope system there are two drums and two ropes—the main rope hauls the full load, and the tail rope the empty load. The number of tubs drawn in one load is sometimes 50 or 60, and the speed 8 to 10 miles per hour, and a single tram road only is necessary.

In the Endless Rope system, instead of drums, a friction-wheel or clutch is used to operate the rope, and the tubs are hauled in sets of two or three, at intervals of 20 or 30 yd., on two sets of rails—one for full and the other for empty tubs. The speed with this system is usually from 2 to 4 miles per hour.

Whilst it is the system more generally adopted than any other in the collieries of this State, it is not so well adapted to roads with many bends as the Main and Tail Rope system.

The engines or dynamos operating the main haulages are usually placed on the surface, but occasionally underground.

For secondary haulages, electrical power is generally used, and there are now many plants placed at considerable distances underground inside the mines driving haulages, as "feeders" to the main system.

As the workings in some of the collieries now extend for more than three miles underground, it will readily be understood that the adoption of secondary haulages has become an economic necessity.

Compressed air may be used instead of electricity where the conditions do not permit of the latter, but, as is well known, the cost of transmitting the former power is much higher, and the efficiency is much less than in the case of electric power.

(*c*) Self-acting inclines, where the full tubs going down a gradient of not less than 1 in 36 draw up the empty tubs. This system is not extensively in use. In steep seams the counterbalance or "dummy" system is common. In this case the "dummy" is loaded to draw up the empty, but the full load in going down draws the "dummy" up.

The most costly part of the haulage is between the working faces and the landings or termini of the mechanical arrangements, and so far no safe and convenient method, suitable to the conditions here, has been devised to replace horses employed in this portion of the haulage system.

Compressed-air locomotives have been used on flat seams with a certain measure of success, and in the United States of America electric locomotives have been used; but when this involves the use of bare wires, from a safety point of view it is a very undesirable system.

It appears to the writer that the best method of doing this work is by means of a further extension of the secondary haulages, with small electrically-driven or compressed-air plants, but there is no doubt great opportunity exists for mechanical ingenuity to economize in this part of the haulage.

Use of Electricity.

The first application of electricity for power purposes in the collieries of this State was to drive a pump underground at the

Co-operative Colliery, Wallsend, in the year 1893. Mr. O. W. Brain, now Chief Electrical Engineer for Tramways, was intimately concerned with this installation.

Its adoption for operating coal-cutting machines commenced in the year 1904 at the Northern Extended Colliery.

Since then its application for power and lighting in and about the collieries has become very general, as may be seen from the attached list, which appears in the Chief Inspector of Coal Mines' report for 1917.

All the electricity used at the collieries is generated by plants operated by the owners, and up to the present there has not been any central power station erected with joint ownership, although this would probably have resulted in considerable economy.

The following prices for electricity for power purposes have been supplied to the writer by Mr. Forbes Mackay, general manager of the Electric Department of the Sydney Municipal Council, and Mr. W. Corin, Chief Electrical Engineer, Department of Public Works :—

PRICES OF ELECTRICITY FOR POWER AND HEATING PURPOSES.

AUSTRALIA.

Place.	Price per Unit. d.	Remarks.
Sydney City Council ..	$1\frac{1}{2}$	Highest price } Power.
	0.6	Lowest price }
Sydney—Balmain Electric Light and Power Supply Corporation Ltd. ..	$1\frac{1}{2}$	Power.
Melbourne—City Council	$1\frac{3}{4}$	Power and heating ; flat rate.
Do. ..	2 and $\frac{1}{2}$	Maximum demand indicator.
Do. ..	$1\frac{1}{2}$	First 1000 units a month.
Do. ..	$1\frac{1}{4}$	Next 2000 ,, ,,
Do. ..	1	,, 2000 ,, ,,
Do. ..	$0\frac{3}{4}$	For the remainder.
Melbourne — Electricity Supply Co.	2	First 1000 units a month } Power and heating.
Do. ..	1	Next 4000 ,, ,,
Do. ..	$0\frac{3}{4}$	,, 15,000 ,, ,,
Do. ..	0.65	For all further consumption.

Place.	Price per Unit.	Remarks.	
Adelaide Supply Corporation	$2\frac{3}{4}$	First 500 units a month	Power.
Do. ..	$1\frac{3}{4}$	Next 2000 units a month	
Do. ..	$1\frac{1}{4}$	All over 2500 units a month	
Do. ..	$1\frac{3}{4}$	Between 11.30 p.m. and 7.30 a.m.	
Do. ..	$2\frac{3}{4}$	All consumption outside these hours.	
Brisbane	£1 per kw. per month plus 3d. per unit. less 50 %		
Launceston	2 to $1\frac{1}{2}$		
Great Britain.			
Aberdeen	$2\frac{1}{2}$ to $0\frac{3}{4}$	Sliding scale. Power.	
Ashton-under-Lyne ..	$1\frac{1}{2}$ to 0.6	Power.	
Bristol	$1\frac{1}{2}$	Power and heating. With discount up to 20 %. or maximum demand $1\frac{1}{2}$d to $0\frac{3}{4}$d. Special rate to large consumers.	
Cardiff	$1\frac{1}{2}$ to $0\frac{1}{2}$	Power. Advanced $12\frac{1}{2}$ %.	
Clyde Valley	3 to $0\frac{3}{4}$	Power.	
Electric Power Co., Edinburgh	$1\frac{1}{8}$ to $0\frac{1}{4}$	Power.	
Belfast	$2\frac{1}{4}$ to 1		
Birmingham	1	Plus 40 % from December, 1916.	
Dublin	$1\frac{1}{4}$		
Glasgow	$1\frac{1}{2}$	First 1000 hours of maximum demand.	
	$0\frac{3}{4}$	For remainder.	
Halifax	2 to $0\frac{5}{8}$	Increased 12 % from July, 1915; less discounts 5 to 30 %.	
Hull	2 to 1		
Liverpool	2	First 3000 units.	
Do.	$1\frac{1}{2}$	3000 to 10,000 units.	
Do.	1	For all over 10,000.	
Newcastle-on-Tyne ..	$1\frac{1}{2}$	Power. Maximum.	
Sheffield	2 to 0.6	Power.	

Place.	Price per Unit.	Remarks.
Walsall..	2	100 units per quarter.
Do.	1¾	200 ,, ,,
Do.	1½	500 ,, ,,
Do.	1¼	Over 500 units per quarter.
Westminster	1	Power, heating, and cooking, plus 10 %.
Wigan	1 to 0½	Power.

It will be seen from this list that the prices paid per unit for power in Australia compare favourably with those of Great Britain.

It would be interesting to know from any of the colliery companies how much it is costing them per unit to generate their electricity.

Manufacture of Coke.

Closely allied to the coal industry is that of the manufacture of coke, a form of fuel largely used in metallurgical processes. The quantity of coke manufactured in this State has been nearly quadrupled during the past twenty years, as the figures for 1901 were 128,882 tons, and the figures for 1917 were 455,587 tons.

The old beehive type of oven is gradually giving way to the rectangular, which lend themselves to the adoption of labour-saving machinery better than the former.

Up to the present the only by-product ovens in operation are those of the Semet Solvay type, built by the Broken Hill Proprietary Ltd. in connection with their blast furnaces, &c., at Newcastle.

It is understood that they have been highly successful, and doubtless members of the Institute will be informed of the good work they are doing in the production of coke and by-products, and also in the application of the waste gases for steam-raising and other purposes.

Apart from the great saving where by-products are recovered, it is unfortunate that so little has been done to use the waste gases for raising steam.

This is done with good results at one of the coke plants on the South Coast, all the electrical power required by a colliery worked by the same firm being generated at the coke ovens.

Mount Kembla	,,	370	A.C.	2200, 440, 415, 550, 220, 500	56	120	8	3	6	Nil	1	,,	,,	,,
		70	D.C.											
Mount Pleasant	,,	352	A.C.	6600	25	125	Nil	2	2	,,	Nil	,,	,,	,,
North Bulli ..	,,	490	A.C.	2300	140	140	,,	8	2	1	17	,,	,,	,,
		975	D.C.	250										
South Bulli ..	,,	350, 350, 105	A.C.	2300, 2300, 2300	85	155	,,	9	7	1	10	,,	,,	,,
		3, 10	D.C.	220, 240										
South Clifton ..	,,	18	D.C.	240	80	38	,,	1	2	Nil	3	,,	,,	,,
		170	A.C.	2300										
South Clifton Tunnel	,,	170	A.C.	2300	9	76	,,	3	2	,,	Nil	,,	,,	,,
		5124												

Western District.

No. 2 Shale Shaft	Western	20	D.C.	250	22	Nil	Nil	2	Nil	1	1	Yes	Yes	Yes
		33	D.C.	250										
		1000	A.C.	440										
Hermitage ..	,,	1.75	D.C.	220	10	,,	,,	Nil	,,	Nil	1	No	,,	,,
Invincible ..	,,	235	D.C.	500	20	28	5	1	2	,,	,,	,,	,,	,,
Ironworks ..	,,	29	D.C.	480	Nil	16	Nil	1	1	,,	,,	,,	,,	,,
Ivanhoe ..	,,	11.5	D.C.	110	1	57	,,	Nil	Nil	,,	,,	,,	,,	,,
Lithgow Valley	,,	13.75	D.C.	550	60	6	,,	,,	,,	,,	,,	,,	,,	,,
Oakey Park ..	,,	29	D.C.	110	33	12	,,	1	3	,,	4	,,	,,	,,
Vale of Clwydd	,,	28	D.C.	550	5	4	3	Nil	2	1	Nil	,,	,,	,,
Zig-Zag ..	,,	50	D.C.	240	45	11	Nil	,,	1	1	2	,,	,,	,,
		1451												
Total ..		17,920.4												

ELECTRICAL APPLIANCES AT MINES UNDER THE COAL MINES REGULATION ACT 1912, AS ON 31ST DECEMBER, 1917.

Name of Colliery.	District.	Generating Plant.			Lighting.		Motors.					Electric Blasting.	Electric Signals.	Telephones.
		Rated current Kw.	Current D.C. or A.C.	Pressure Volts.	Lamps on Surface.	Lamps in Mine.	Coal-cutters.	Haulage.	Pumps.	Fans.	Other Uses.			
Northern District.														
Aberdare ..	Maitland	1,150	A.C and D.C.	2200 415 428 250 220	210	365	20	4	7	Nil	12	Yes	Yes	Yes
,, Central	,,	7½	D.C.	250	97	Nil	Nil	Nil	1	,,	Nil	,,	No	,,
,, Extended	,,	890	A.C. and D.C.	A 2200 415 C 428 415 DC 250	275	250	20	4	5	2	6	,,	Yes	,,
,, South	,,	407½	A.C.	6600 2200	42	Nil	Nil	Nil	Nil	Nil	Nil	,,	No	,,
Abermain ..	,,	180 100 80 10	D.C.	250	120	110	20	4	6	1	5	Partly	Yes	,,
,, No. 2	,,	250 21	D.C.	250	86	40	4	2	3	1	8	,,	,,	,,
Bellbird ..	,,	912 100	A.C. D.C.	2200 250	110	50	10	3	4	1	5	Yes	,,	,,
Burwood Extd	Newcastle	100 20	D.C.	250–275 220	12	10	6	2	4	Nil	4	,,	,,	,,
Dudley ..	,,	7½	D.C.	240	7	8	Nil	Nil	1	,,	Nil	,,	No	,,
East Greta ..	Maitland	120	A.C.	2200	130	30	,,	1	4	2	3	No	Yes	,,
Gunnedah ..	Gunnedah	100	D.C.	250–275	9	8	3	1	Nil	1	1	,,	,,	,,
Hebburn ..	Maitland	280	D.C.	250–275	206	31	21	3	1	Nil	7	Yes	,,	,,
Lymington ..	Newcastle	400	D.C.	500	6	18	7	2	3	3	5	,,	,,	,,
Neath ..	Maitland	150 6½	D.C.	500 220	38	28	11	4	Nil	1	2	No	,,	,,
Newcastle Coal Mining Co.'s "A" Pit	Newcastle	5	D.C.	110	58	60	Nil	Nil	,,	Nil	Nil	,,	,,	,,
Northern Extended	,,	300	D.C.	250	6	18	6	1	5	,,	1	,,	,,	,,
Northumberland	,,	75 20	D.C. D.C.	300 260	6	1	2	Nil	2	,,	Nil	,,	,,	,,
Pacific ..	,,	200 55	D.C.	250 250	20	50	5	1	Nil	,,	,,	,,	,,	,,
Pelaw Main ..	Maitland	—	A.C.	3000 500 220	498	113	Nil	6	3	1	8	Yes	,,	,,
Rhondda ..	Newcastle	62	D.C.	250	16	Nil	4	Nil	Nil	Nil	Nil	No	,,	,,
Richmond Main	Maitland	2000 750	A.C. D.C.	3300 800	279	58	Nil	1	7	,,	9	Yes	,,	,,
Rothbury ..	,,	140	D.C.	240	191	40	,,	Nil	3	3	5	,,	,,	,,
Seaham No. 1	Newcastle	6	D.C.	240	96	25	,,	,,	Nil	3	Nil	,,	,,	,,
Seaham No. 2	,,	5.75	D.C.	125	70	48	,,	,,	,,	1	,,	,,	,,	,,
South Greta ..	Maitland	70 70 80	D.C.	250 550 250	10	8	,,	3	4	1	,,	No	,,	,,
Stanford-Merthyr	,,	200 250 350 350	D.C. A.C.	250 2200	190	110	,,	10	6	7	7	Yes	,,	,,
Stockton Borehole	Newcastle	70 4	A.C. D.C.	500–250 110	Nil	6	,,	Nil	3	Nil	Nil	,,	,,	No
Wallarah ..	,,	470	D.C.	250	93	90	17	5	9	Nil	9	No	,,	Yes
Waratah ..	,,	7½	D.C.	250	24	44	Nil	Nil	2	,,	1	,,	,,	,,
West Wallsend	,,	3.15 175	D.C. A.C.	105 650	40	64	,,	2	2	1	3	Yes	,,	,,
West Wallsend, Killingworth	,,	60 10	D.C.	250	50	45	,,	Nil	Nil	1	2	,,	,,	,,
Whitburn ..	Maitland	200 50 15	A.C. D.C. D.C.	440 550 110	53	36	,,	4	1	Nil	3	No	,,	,,
		11,345.4												
Southern District.														
Bull ..	Southern	400	A.C.	2300	15	115	4	3	1	2	5	Yes	Yes	Yes
Coal Cliff ..	,,	400 202 15	D.C.	250 to 275	54	65	4	4	3	Nil	2	,,	,,	,,
Corrimal-Balgownie	,,	400 160	A.C.	6600 2300	45	46	Nil	2	3	1	3	,,	,,	,,
Excelsior ..	,,	100	A.C.	440	48	131	,,	1	3	2	Nil	,,	,,	,,
Metropolitan ..	,,	14	D.C.	250	84	112	,,	Nil	Nil	1	1	,,	,,	,,
Mount Kembla	,,	370	A.C.	2200 440 415 550 220	56	120	8	3	6	Nil	1	,,	,,	,,
		70	D.C.	500										
Mount Pleasant	,,	352	A.C.	6600	25	125	Nil	2	2	,,	Nil	,,	,,	,,
North Bulli ..	,,	490 975	A.C. D.C.	2300 250	140	140	,,	8	2	1	17	,,	,,	,,
South Bulli ..	,,	350 350 105	A.C.	2300 2300 2300	85	155	,,	9	7	1	10	,,	,,	,,
		3 10	D.C.	220 240										
South Clifton ..	,,	18	D.C.	240	80	38	,,	1	2	Nil	3	,,	,,	,,
		170	A.C.	2300										
South Clifton Tunnel	,,	170	A.C.	2300	9	76	,,	3	2	,,	Nil	,,	,,	,,
		5124												
Western District.														
No. 2 Shale Shaft	Western	20 33 1000	D.C. D.C. A.C.	250 250 440	22	Nil	Nil	2	Nil	1	1	Yes	Yes	Yes
Hermitage ..	,,	1.75	D.C.	220	10	,,	,,	Nil	,,	Nil	1	No	,,	,,
Invincible ..	,,	235	D.C.	500	20	28	5	1	2	,,	,,	,,	,,	,,
Ironworks ..	,,	29	D.C.	480	Nil	16	Nil	1	1	,,	,,	,,	,,	,,
Ivanhoe ..	,,	11.5	D.C.	110	1	57	,,	Nil	Nil	,,	,,	,,	,,	,,
Lithgow Valley	,,	13.75	D.C.	550	60	6	,,	,,	,,	,,	,,	,,	,,	,,
Oakey Park ..	,,	29	D.C.	110	33	12	,,	1	3	,,	4	,,	,,	,,
Vale of Clwydd	,,	23	D.C.	550	5	4	3	Nil	2	1	Nil	,,	,,	,,
Zig-Zag ..	,,	50	D.C.	240	45	11	Nil	,,	1	1	2	,,	,,	,,
		1451												
Total ..		17,920.4												

Messrs. G. and C. Hoskins also hope to adopt the same system at the Wongawilli and Lithgow coke ovens.

At the present time it is very costly to erect by-product ovens and plant, but doubtless after the war prices will approach the normal again, and, with the experience of the ovens referred to above, much more will be done in the direction of saving what is now going to waste.

The coals best suited for the manufacture of coke in the Northern district are from the Borehole seam and the Four-Mile Creek seams, near East Maitland; and the Rix's Creek seams, near Singleton.

It would appear probable that there is a considerable extension of the latter coal-field in the vicinity of Ravensworth, where a number of seams of workable thickness were proved by two diamond drills put down in the years 1888 and 1889.

Professor David, on page 266 of the "Geology of the Hunter River Coal Measures," makes the following reference to the coal in this locality :—

"While the friable nature of the coal renders it on the whole unsuitable for export, its purity makes it well fitted for local use as a gas or household coal, as well as for steam purposes, and, as already stated, coke of excellent quality can be produced from it—in fact, coke from the Rix's Creek area is one of the best that is manufactured in New South Wales for metallurgical purposes. It is not quite as strong as the coke made from the Bulli seam, and will not therefore bear such a heavy load of ore without being crushed under the weight of it, as will the Bulli coke; but in the matter of freedom from ash it is superior to the latter."

The Ravensworth portion of this field is entirely undeveloped, and it probably contains large quantities of coal suitable for making a good metallurgical coke.

In the Southern district, the Top or Bulli seam and the No. 2 or Four-Feet seams produce the best coke; and recently the No. 3 seam is being used by Messrs. G. and C. Hoskins for this purpose.

In the Western district the coke is at present made from the Lithgow seam, but the product is somewhat soft, and not as suitable as the Bulli coke for blast-furnace purposes. It has been found that a mixture of the Lithgow and Southern coals produces a better coke.

The best coke produced in this district was made some years ago in beehive ovens from 2 ft. 9 in. of the upper portion of the Wolgan seam, then worked by the Commonwealth Oil Corporation Ltd.; but this plant is not working at present—in fact, it is being dismantled.

Little has been done in the matter of trying to reduce the ash contents of coke by washing the coal, and as there is no coke made here containing less than 10 % of ash, and some of it contains more than 15 %, there is great opportunity for improving the coke by removing some of the dirt mixed with the coal by washing it.

The quantity of coke made in 1917 from the respective districts was as follows :—

	Tons.
Northern	111,803
Southern	297,904
Western	45,880
	455,587

Having regard to the great value of the by-products to be obtained from coal—both for purposes of commerce and war—it appears to be advisable that analyses and research work be carried out by the Department of Mines, the University, technical colleges, and the mine-owners, with a view to ascertain more definitely the value of our coal in respect of by-products, apart from their coking qualities.

For further particulars of the coke industry the writer would refer members to a useful little book, entitled "Coke Industry of New South Wales," by Mr. L. F. Harper, geological surveyor, with analyses and notes on by-products by J. C. H. Mingaye, F.I.C., F.C.S., analyst and assayer (1916).

Coal Resources, Output, and Disposal of Same.

The latest estimate of the quantity of coal available in New South Wales is to be found in Pittman's "Coal Resources" (1912), and it is prefaced by the remark that "any estimate of the quantity of coal in New South Wales must be based upon very uncertain data."

The calculation is based on the assumption that a thickness of 10 ft. of coal underlies an area of 16,550 sq. miles, and taking 84 lb.

as the average weight of a cub. ft. of coal, and deducting one-third for loss in working, impurities, &c., this would represent a total quantity of 115,346,880,000 tons within a depth of 4000 ft. in the Permo-Carboniferous coal-measures. This is equal to 60 % of the coal resources of Great Britain, computed as 189,535,000,000 tons, by the Royal Commission on "Coal Supplies" in their report of 1905.

On the basis of an annual output of 10,000,000 tons, the coal in this State would last for 11,534 years, and, with an output of 100,000,000 tons (or ten times more than at present), our coal supplies would last for 1153 years.

These are very reassuring figures; but the writer ventures to suggest that if as a result of recent provings by boreholes, the large quantities of coal which have to be left for the protection of public works, the unavoidable loss in working thick seams, &c., a more detailed examination of the coal resources was made it would probably be found that the available supply was much less. But, quite apart from the question as to whether the quantities of coal available are likely to be more or less than given by present estimates, it is desirable that the ascertainment of these quantities should be based on the best and latest sources of information.

This is a matter which might form a very useful subject for inquiry by the various branches of the Department of Mines, with the assistance of the officers of the colliery companies.

Professor David, on page 263 of "Geology of the Hunter River Coal Measures," estimated at the time (1907) that the following quantities of coal were available for future working in the various seams in the Newcastle coal field :—

	Tons.
Borehole seam	1,216,000,000
Burwood seam	1,346,000,000
Australasian seam	1,555,000,000
Great Northern seam	943,000,000
Wallarah seam	257,000,000
	*5,317,000,000
Less one-third for waste in getting, faults, rolls, &c.	3,545,000,000

* Owing to a clerical error, this was given as 4,917,000,000 tons.

Of these seams the Borehole has supplied the fuel which has made Newcastle so well known for its coal, none of the others being equal to it in quality or general usefulness.

Practically all of the thickest of the coal in this seam was in the collieries near to the city, and which have now ceased working.

Having regard to the areas of thin and unworkable coal proved in this seam, and also to that already left in abandoned collieries, it is not likely that Professor David's estimate of 1,216,000,000 tons will be recoverable from this seam, unless it extends much further to the south, of a workable thickness, and in this connection it does not promise well, especially near the coast.

So far no estimate seems to have been made of the coal available in the Tomago measures in the Hexham and Maitland districts. In reference to the Maitland coal field, Professor David estimates that there are 158 sq. miles, containing 1,262,000,000 tons available for working, after deducting one-third for loss in getting the coal.

A recent development of coal-working at Muswellbrook has disclosed a fine seam in the Greta measures, which is likely to add a large quantity, similar in quality to that found in the Maitland coal-field, to the available coal resources of the Northern district.

SOUTHERN COAL-FIELD.

Mr. L. F. Harper, F.G.S., refers in cautious terms to the available coal in the Southern coal-field on pages 211–213 of his "Geology and Mineral Resources" of 1912.

In the Top or Bulli seam now being worked by all the collieries from Helensburgh to Mount Kembla, he estimates in round numbers that 500,000,000 tons of coal remain to be worked.

In this district the catchment area for the Sydney water supply (approximately 354 sq. miles in extent) is situated, whilst the submerged area when the reservoir is full is 2200 acres.

At present the arrangement with the Metropolitan Water and Sewerage Board does not allow any coal to be won from the

catchment area, except by shafts or tunnels outside of it; and in order to prevent possible leakage from the submerged area a large percentage of the coal has to be left under it.

It will thus be seen that these conditions place further limitations on the quantity of coal that may be worked from this district.

With reference to the lower seams, Mr. Harper makes the following remarks:—

"The future may probably see active coal mining south from Mount Kembla, particularly in connection with seams Nos. 2, 3, and 4. It is estimated that about 100 square miles of country may be found to contain coal worthy of future attention, with a total thickness of 12 feet, and from this source 800 million tons should be available."

As a matter of fact, the No. 3 seam is now being worked at Messrs. G. and C. Hoskins' Wongawilli Colliery.

No. 2 seam has been roughly estimated to contain 200,000,000 tons of available coal.

Unfortunately, these lower seams, with the exception of No. 2, are much intermixed with bands of dirt, which will necessitate careful cleaning and washing.

Summarizing, Mr. Harper estimates that the total quantity of coal within the Illawarra coal field at one thousand five hundred million (1,500,000,000) tons, but with this important reservation —viz., "two-thirds of which will probably fall short of present-day standards as regards quality."

WESTERN COAL-FIELD.

No separate estimate of the quantity of coal likely to be available in this field has been made.

OUTPUT OF NORTHERN DISTRICT SINCE 1902.

Borehole and Greta Seams Outputs Compared.

Since 1902 the outputs from the various seams have been as shown on p. 62. Those of the Borehole, Greta, and other seams are given, and from these figures it will be seen the product of the Greta measures has to a large extent displaced that from the Borehole seam.

In the year 1903 the Borehole seam yielded 71.5 % of the total output of the Northern district, whilst that from the Greta measures was only 12.95 %.

An examination of the table will show a gradual decrease in the former and an increase in the latter, until for last year the output from the Borehole seam has decreased to 23.86 %, whilst that from the Greta seams has increased to 57.78 % of the total for the Northern district.

A further inspection of the table shows that the output from all the other seams has been a fairly regular proportion of the whole.

Owing to the advice of Professor David, after careful geological examination of the district, the areas now taken up by several of the Maitland Cessnock collieries was set apart as a mining reserve, and the thanks of the public, and the mining community in particular, are due to him for pointing out in his many reports the great potentialities of this field.

PROGRESS OF OUTPUT.

Year.	Borehole Seam.	%	Greta Seam.	%	Other Seams.	%
	Tons.		Tons.		Tons.	
1903	3,153,746	71.50	571,096	12.95	685,723	15.55
1904	2,617,694	64.75	964,030	23.84	461,015	11.41
1905	2,802,747	60.36	1,213,057	26.13	627,706	13.51
1906	3,174,992	59.54	1,316,702	24.69	840,048	15.77
1907	3,302,319	54.51	1,871,624	30.89	884,637	14.60
1908	2,929,951	45.00	2,489,911	38.24	1,091,190	16.76
1909	1,904,910	39.67	2,184,098	45.49	712,353	14.84
1910	1,879,015	35.01	2,690,109	50.12	797,851	14.87
1911	2,059,789	35.55	2,935,887	50.67	797,970	13.78
1912	2,571,967	37.20	3,333,355	48.21	1,008,488	14.59
1913	2,503,817	33.83	3,721,331	50.28	1,177,479	15.89
1914	2,768,673	38.90	3,016,970	42.46	1,328,348	18.64
1915	1,803,533	28.59	3,564,408	56.51	939,074	14.90
1916	1,268,324	23.88	3,224,156	60.69	819,352	15.43
1917	1,283,805	23.86	3,109,220	57.78	987,932	18.36

The following table gives the outputs from the Northern, Southern, and Western districts since the year 1900 :—

During that period the following percentages have been raised from the respective districts :—

	%
Northern	68.20
Southern	22.96
Western	8.84

The only district at present opening out collieries likely to produce large outputs in the near future is the Maitland–Cessnock, so that the Northern coal-field will probably continue to hold its present position for many years.

Year.	Northern.	Southern.	Western.	Total Output.
	Tons.	Tons.	Tons.	Tons.
1901 ..	3,999,252	1,544,454	424,720	5,968,426
1902 ..	3,900,297	1,588,473	453,241	5,942,011
1903 ..	4,410,565	1,476,005	468,276	6,354,846
1904 ..	4,042,739	1,558,383	418,687	6,019,809
1905 ..	4,645,742	1,556,678	429,718	6,632,138
1906 ..	5,336,188	1,783,395	506,779	7,626,362
1907 ..	6,058,580	1,835,425	763,919	8,657,924
1908 ..	6,511,002	1,929,236	706,787	9,147,025
1909 ..	4,801,361	1,619,675	598,843	7,019,879
1910 ..	5,366,975	1,875,009	931,524	8,173,508
1911 ..	5,793,646	2,066,621	831,337	8,691,604
1912 ..	6,913,810	2,172,800	799,205	9,885,815
1913 ..	7,402,627	2,081,472	930,066	10,414,165
1914 ..	7,113,991	2,362,741	913,890	10,390,622
1915 ..	6,307,015	2,261,398	880,595	9,449,008
1916 ..	5,311,832	1,848,933	966,396	8,127,161
1917 ..	5,380,957	1,841,869	1,070,041	8,292,867
	93,296,579	31,402,567	12,094,024	136,793,170
Per cent...	68.20	22.96	8.84	100.00

DISPOSAL OF COAL.

The following table shows the percentages of the output for inter-State and foreign export and for home consumption :—

Year.	Disposal of Output—Percentages.			Output.
	Inter-State Export.	Foreign Export.	Home Consumption.	
				Tons.
1901	35.51	22.64	41.85	5,968,426
1902	32.47	22.24	45.29	5,942,011
1903	31.97	30.76	37.27	6,354,846
1904	31.24	21.47	47.29	6,019,809
1905	31.15	24.90	43.93	6,632,138
1906	29.63	35.42	34.95	7,626,362
1907	27.48	38.86	33.66	8,657,924
1908	29.69	36.99	33.32	9,147,025
1909	31.34	31.24	37.42	7,019,879
1910	30.32	27.06	42.62	8,173,508
1911	29.06	28.74	42.20	8,691,604
1912	31.32	29.91	38.77	9,885,815
1913	33.28	26.56	40.16	10,414,165
1914	24.85	31.63	43.52	10,390,622
1915	27.52	21.88	50.60	9,449,008
1916	27.12	15.14	57.74	8,127,161
1917	(Figures not available.)			8,292,867

The effect of the European war has been bad both for the inter-State and foreign export trade, but particularly the latter.

It is fortunate that the home requirements have absorbed some of the coal, counterbalancing the reduced export quantities to some extent, the percentage of coal used for home consumption having increased from 41.85 % in 1901 to 57.74 % in 1916 ; and further increases in the same direction would be an indication of industrial and manufacturing activity, which, for the progress of this State, would be much more beneficial than a large foreign export trade in coal.

Incidentally, it may be mentioned that the Australian output of coal (to which New South Wales contributes fully 80 %) is equal to about half the total quantity mined to the south of the equator, so that after the war, with a probable increase of home industries, if industrial peace can be assured, there should be a bright future for the coal trade of this State.

Wages Paid to the Various Classes of Labour at Collieries in the Newcastle and Maitland Districts, June, 1918.

As a record for the future, and for comparison with the wages paid at metalliferous mines, the following particulars are given. These were furnished by Mr. C. M. M'Donald, secretary to the Northern Collieries Association :—

RATES PAID DAY-WAGE EMPLOYÉS, NORTHERN DISTRICT, NEW SOUTH WALES, JUNE, 1918.

	Maitland. per day. s. d.	Newcastle. per day. s. d.
Deputy	16 6	16 0
Shot-firer	15 6	15 0
Waste-examiner	15 6	15 0
Examining deputy	—	15 0
1st class shiftman	15 6	13 11
2nd class ,,	11 5	10 11
Wheelers	11 8	—
Wheelers, 18 years and over	—	11 2
Wheelers under 18 years	—	10 6

	Maitland and Newcastle. per day. s. d.
1st class roadmen	13 2
2nd class ,,	11 4
Onsetters	12 7
Onsetters' assistant	10 11
Banksmen	12 7
Bankers-off	10 11
Lampmen	10 11 and 11 2
Lampmen's assistant	10 11
Horsekeepers	10 11
Horsekeepers' assistant	10 11
Waggon packers	10 11
Shunters	10 11
Screenmen	10 11
Belt hands	10 11
Waggon shifters	10 11

	Maitland and Newcastle. per hour. s. d.
Engineers' smiths	1 10
,, fitters	1 9½
Turners	1 9½
Coppersmiths	1 10
Patternmakers	1 10½
Deputy electrician	1 8⅜
Machine deputy	1 6
Cable hangers	1 6¼
Electrical fitter	1 10½
,, mechanic	1 8⅜
Planers (whilst so engaged)	1 8⅜
Slotters ,, ,, ...	1 8⅜
Millers ,, ,, ...	1 8⅜
Shapers ,, ,, ...	1 8⅜
Drillers ,, ,, ...	1 5¾
Other machinists (whilst so engaged)	1 5¾
Blacksmiths	1 9
Colliery fitters	1 7¼
Horse-shoers	1 8¾
Pick-sharpener and horse-shoer	1 6¼
Pick-sharpener	1 5¾
Striker	1 5⅛
Carpenter	1 10
Skip or hopper repairers	1 6¼
Bricklayers, when employed on stoppings	1 7½
,, when otherwise employed	1 9½
Bricklayers' labourers, when employed supplying by hod ..	1 7¾
Circular sawyers, who work, sharpen, and set any saw	1 7¾
,, ,, cutting timber 9 in. and over in depth ..	1 7¾
,, ,, ,, ,, 6 in. and 9 in. in depth ..	1 6
All other flat cutting-bench circular sawyers	1 4⅜
Re-cutting band sawyers, diam. of wheel being 60 in. or over	1 7¾
Re-cutting band sawyers, diam. of wheel being over 48 in. and under 60 in.	1 6
Re-cutting band sawyers, diam. of wheel being 48 in. and under	1 4⅜

	Maitland and Newcastle. per hour. s.	d.
Circular-saw sharpeners	1	$7\frac{3}{4}$
,, doctors	1	$9\frac{1}{2}$
Log sawyers (other than band sawyers)	1	$5\frac{3}{8}$
Tailer-out	1	$4\frac{3}{8}$
Gangers	1	$8\frac{3}{4}$
Fettlers	1	$4\frac{3}{8}$
Boilermakers	1	$9\frac{1}{8}$
Moulders	1	$7\frac{3}{4}$
Riggers in charge	1	$7\frac{3}{4}$
Other riggers	1	$4\frac{3}{8}$
Saddlers	1	6
Storemen in charge, and distributors of explosives ..	1	$5\frac{3}{4}$
Other storemen	1	$4\frac{5}{8}$
Weighman	1	$6\frac{7}{8}$
Carter driving one horse	1	$4\frac{3}{8}$
.. ,, two horses	1	$4\frac{3}{4}$
Painters, whilst engaged in sign-writing, not including stencil work	1	$10\frac{3}{8}$
Painters, whilst engaged painting offices or residence ..	1	$8\frac{5}{8}$
Plumbers	1	$8\frac{3}{8}$
Waggon greasers	1	$4\frac{3}{8}$
Rope splicer (whilst so engaged)	1	$6\frac{7}{8}$
Other labourers	1	$4\frac{3}{8}$
Painters doing colliery work, not included in above ..	1	$5\frac{1}{8}$
	per day.	
Boys and Youths—From 14 years to 15 years ..	4	4
,, 15 ,, ,, 16 ,, ..	5	8
,, 16 ,, ,, 17 ,, ..	6	8
,, 17 ,, ,, 18 ,, ..	7	8
,, 18 ,, ,, 19 ,, ..	8	8
,, 19 ,, ,, 20 ,, ..	9	8
,, 20 ,, ,, 21 ,, ..	10	8
Locomotive drivers	14	5
,, ,, If railway gauge be not more than 3 ft.	13	5
Winding-engine driver	14	5
Crane-engine driver—		
(*a*) If crane exceeds 5 tons	14	5
(*b*) If crane does not exceed 5 tons	13	2

	Maitland and Newcastle. per day. s.	d.
Traction-engine driver (steam or oil)	13	9
Winch driver	13	2
If working underground he does not raise or lower men	12	0
Other engine drivers—		
(*a*) If the engine or engines have steam for their motive power and have a single cylinder with a bore exceeding 12 in. in diameter, or have singly or together two or more cylinders, the sum of the area of whose bores exceed the area of a circle 12 in. in diameter (that is to say, exceeds 113.0976 sq. in.)—		
With condenser	13	9
Without condenser	13	2
(*b*) In the case of suction-gas engines or other internal-combustion engines of over 50 b.h.p.	13	2
(*c*) In other cases	12	0
But if the engine-driver also attends an electric generator or dynamo (other than a dynamo for merely lighting the works) he shall have an additional payment—		
(*a*) If cylinders over 24 in.	1	0
(*b*) If ,, not over 24 in. ..	0	6
If engine-driver be also in charge of a plant, he shall have an additional payment of ..	1	0
Firemen, locomotive	12	0
Other firemen—		
(*a*) If attending one boiler or suction-gas generator..	10	11
(*b*) If attending two boilers	11	7
(*c*) If attending three or more boilers	12	0
Trimmers	10	11
Greasers or engine cleaners—		
(*a*) If adult	10	11
(*b*) If under 16 years of age	4	10
(*c*) If 16 but under 18	6	0
(*d*) If 18 ,, ,, 19	7	2
(*e*) If 19 ,, ,, 20	8	5
(*f*) If 20 ,, ,, 21	9	7
But if they sometimes, under the control of an engine-driver, stop or start the engine, an additional	1	0

	Maitland and Newcastle.
	per hour.
	s. d.
Boiler cleaners—	
(*a*) If and while at dirty work	1 $9\frac{5}{8}$
(*b*) If not at dirty work	1 $4\frac{1}{2}$
Motor attendants or drivers—	per day.
(*a*) Where the motor or motors to which the employé attends exceed 50 h.p. in all	11 6
(*b*) Where motors do not exceed 50 h.p. in all—	
If the attendant be under 16 years of age ..	5 2
.. „ „ 16 but under 18 ..	6 4
.. „ „ 18 „ „ 19	7 5
„ „ „ 19 „ „ 20	8 11
„ „ „ 20 „ „ 21	10 4
„ „ „ 21 or over	11 6
Sub-station attendants	12 8

Bibliography.

Annual Reports of the Department of Mines, New South Wales, from 1874 to 1917; contain mining, geological, and statistical information.

"Working Coal under the Hunter River, Pacific Ocean, and its Tidal Waters near Newcastle," by A. A. Atkinson, Chief Inspector of Coal Mines, New South Wales. Federated Institute of Mining Engineers, vol. xxiii., page 622.

"The Geology and Mineral Resources of the Western Coal Field," by J. E. Carne, Assistant Government Geologist. 1908.

"The Kerosene Shale Deposits of New South Wales," by J. E. Carne, Assistant Government Geologist. 1903.

"Sedimentary Deposits of New South Wales," by Rev. W. B. Clarke. 1878.

"Coal Fields of Australasia," by Herbert S. Cox. Federated Institute of Mining Engineers, vol. ii., page 321.

"Contributions to a List of Papers Dealing with the Economic Geology of New South Wales." Records Geological Survey, by W. S. Dun. 1900, vol. vi., pages 270–296.

"The Geology of the Hunter River Coal Measures, New South Wales," by T. W. Edgeworth David, B.A., F.R.S., F.G.S., Professor of Geology and Physical Geography in the University of Sydney. 1907.

"Geology and Mineral Resources of the Southern Coal Field," by L. F. Harper, F.G.S., Geological Surveyor. 1915.

"The Coke Industry of New South Wales." Descriptive Notes by L. F. Harper, F.G.S., Geological Surveyor; Analysis and Notes on By-Products by J. C. H. Mingaye, F.I.C., F.C.S., Analyst and Assayer. 1916.

"New South Wales Coal Fields," by W. Keene, F.G.S. Paper in "Industrial Progress of New South Wales," 1870.

"The Minerals of New South Wales, &c.," by A. Liversidge, M.A., F.R.S., Professor of Chemistry and Mineralogy in the University of Sydney. 1888.

"The Coal Resources of New South Wales," by Edward F. Pittman, A.R.S., Government Geologist and Under Secretary for Mines, New South Wales. 1912.

"Mineral Resources of New South Wales," by E. F. Pittman, A.R.S.M., Government Geologist. 1901.

"Coal Fields and Collieries of Australia," by F. Danvers Power. 1912.

"Coal Fields South of Sydney," by James R. M. Robertson. Federated Institute of Mining Engineers, vol. iv., page 83.

"Geology of New South Wales," by C. A. Süssmilch, F.G.S., Principal of the Technical College, Newcastle. 1914.

"Notes on Coal Fields of New South Wales," by G. B. Walker. Federated Institute of Mining Engineers, vol. ii., page 268.

"Mineral Products of New South Wales," by Harrie Wood, Under Secretary for Mines. 1887.

"Notes on the Geology of New South Wales," by C. S. Wilkinson, F.G.S., Geological Surveyor-in-Charge; and "Description of the Seams of Coal Worked in New South Wales," by John Mackenzie, F.G.S., Examiner of Coal Fields. 1887.

"Mount Kembla Colliery Disaster (31st July, 1902): Report of the Royal Commission, Together with Minutes of Evidence and Exhibits." 1903.

"Report of the Committee of Inquiry into the Use of Electricity in Coal Mines." 1908.

"Report of the Committee of Inquiry into the Best Method of Dealing with Coal Dust in Collieries of This State." 1914.

DISCUSSION.

Mr. C. A. Sussmilch said there was one point brought out in Mr. Atkinson's paper that was of very great importance, and which, he thought, should be emphasized, and that was the waste of coal in coal-mining. He thought Mr. Atkinson referred to the fact that, in the neighbourhood of Newcastle, in the Borehole seam, as much as 60 % of the coal was left in the ground when certain collieries were closed down and abandoned. On the Maitland field, where there was the finest seam in the State, or in Australia, he doubted whether more than 45 % of the coal would be taken out of the ground by the system then in use. They knew that mining companies were not charitable institutions —they had to make a profit for their shareholders, and they may be bound down by certain restrictions; but he thought it was a reflection on the mining profession that the waste of coal should exist. He could not give the exact figures, but he thought that in Great Britain not more than 33 % of the coal was left in the ground; the remaining 67 % was won. It ought to be possible in Australia to get the same result. He did not wish his remarks to be taken as a reflection on any particular colliery, but he thought it was time that they in Australia took into consideration the question whether or not they were doing as much as they should with the things at their hand. Mr. Atkinson said they had coal sufficient to last for 11,500 years at the present rate of output, and with those figures before them they were apt to be careless about the utilization of their coal resources. They must remember that the coal-seams now being worked (and wasted) were their best seams: the less valuable seams included in that estimate were not being worked to any extent. They should look upon it that they were the trustees of the coal resources of the State, and that it was their duty not to waste those resources, and to leave something for posterity. The present generation did not provide the coal-measures: they were provided for the whole of mankind, and it was for the mining profession to see that the best use was made of them. Under Newcastle itself, it was

perhaps not possible to take out more coal, because large pillars had to be left underground where a large city stands; but that was not the case everywhere. He knew of one colliery in another district with a 12-ft. seam, and only 8 ft. of the coal had been taken out of it. They were losing 4 ft. because it was not as good. That would not be so bad if it were available later on; but that was not so—it was being destroyed for all time. His remarks were general, and it might be that it was not possible to do better than they were doing; but he maintained that it was their duty to see that the best results attainable should be arrived at, and that a great national asset like the coal resources should not be wasted. They had seen during the war how countries without coal resources had to suffer, and it should be an inducement to see that resources of that kind were conserved.

Mr. Poole said he wished to fully endorse the remarks made by Mr. Süssmilch. A question of that nature was brought up in the United States a number of years ago, in the form of jeering at what was being done in Great Britain. It was pointed out that in the United States a greater tonnage was being mined per man, and at a lower rate per ton per man, although the daily rate of wages for labour was somewhat higher than in Great Britain. Some British engineer delved into the question, and it was shown that many American collieries were taking out only 30 % or 40 % of the coal, and leaving the rest as waste, whereas the British collieries were winning a much larger amount. Recently—during President Wilson's term of office—the question of the conservation of national resources had received keen attention in America. He did not know if any steps had been taken to put those ideas into practice; but he should not be surprised if strict legislation were enforced in the United States to save the national assets. Coal was a wasting asset. If used, it is gone; or if portion is left in the ground under such conditions that no man can work it, it is wasted as well. There was also an important matter which metalliferous engineers could study with benefit—namely, the keen attention given in coal-mining to ventilation.

Most metal mines would ventilate themselves in a more or less indifferent manner, but a coal-mine usually would not. It was therefore necessary to attack the problem of properly ventilating the pit; and so, with the more difficult problem, they achieved a much better result than in metalliferous mines, where there was often no serious attempt to better the conditions. He mentioned a metalliferous mine in which the conditions were not only improved by proper ventilation, but the life of the mine prolonged —viz., Brilliant Extended mine in Charters Towers; it was from 2000 to 3000 ft. deep, and at that time the deepest-worked mine outside of Bendigo. At one particular stage the ventilation had got to such a bad condition that it was almost impossible for men to work in it. The then manager knew what should be done, and he employed an old coal-mine ventilating man to go into the problem, and, by directing the air currents round the mine, the deepest mine on the field became practically one of the coolest and best ventilated. In connection with the coking of coal industry, there was the same scandalous waste—he had nearly said criminal waste—as had been referred to in the mining of coal. It was not so noticeable in the Newcastle district as in the Illawarra district, where at night time the flares were to be seen in thousands, illuminating one patch after another. Not a coking plant there was making use of its waste gas, except in one case—for heating a boiler. The question of utilizing the by-products of the ovens came up a few years ago, when it was proposed to put an installation in one of the Illawarra line suburbs of Sydney to dispose of the gas for domestic purposes and sell the by-products. But one thing, among others, which prevented this was that a market for the gas could not be found. The *Gas Act* of New South Wales said that the gas for town supply must be of a certain calorific value and candle power, but it was difficult to obtain that quality in gas from coke ovens. The Government proposes to amend the *Gas Act*, and the Engineering Association of New South Wales recommended that special standards should be fixed, by which coke-oven gas could be supplied to towns for domestic purposes, viz.:—provision should be made beforehand

for companies to do it, rather than that companies should obtain special legislation later, which no company liked to undertake. The question of technical standards was one which he thought Australasian Institute of Mining Engineers could take up with advantage.

Mr. Ward said he would like to say a few words in thanking Mr. Atkinson for the excellent paper he had prepared and presented to the Institute. It was one of the most valuable things they could have for use—a masterly summary of that kind. Those who, like himself, came from the other States, appreciated only too keenly the good fortune of New South Wales in possessing that vast store of fuel. It was the magnet that had brought the Iron Mountain to Newcastle ; and their regret was that, in South Australia at all events, the coal did not follow the example of Mahomet, and go to the mountain. He would very much like Mr. Atkinson's views upon the subject which Mr. Süssmilch had so ably put before the meeting that night ; and that was, the putting into practical effect of measures for the more effective working and for the conservation of the coal resources of the State. That would be a valuable addition to Mr. Atkinson's paper. He came from a country that did not possess coal resources comparable to even the smallest of the coal measures of New South Wales. They wished that they had them, and they could see clearly that New South Wales had been doubly blessed in that it would not only have the mining industry in its midst, but would attract all those secondary industries which depended upon fuel resources ; just as in Great Britain the coal-measures had drawn other industries to the coal-bearing areas, so those must ever grow round Newcastle.

Mr. D. N. Morison said he would like from Mr. Atkinson an opinion upon the relative value of the bord and pillar system of coal-mining and the longwall system. The system of mining was very much involved in the question Mr. Süssmilch raised—viz., the matter of waste in coal-winning. He (Mr. Morison) believed there was a considerable difference in the quantity of coal won under one system as against the other ; and he would like

Mr. Atkinson to tell them the advantages of the bord and pillar system over the longwall system. He understood that only one colliery in the district was working under the longwall system.

Mr. C. T. Stephenson said Mr. Atkinson's paper seemed to suggest that colliery owners raised difficulties when requested to furnish costs of generating power. He did not know if that was the case with regard to collieries, but it certainly was so where other industries were concerned. In many cases owners did not know what their costs were; they did not keep them separate, because they did not realize the economy that was possible as a result of intelligent treatment of the subject. In any case, the absence of reliable figures made it very difficult for those who wished to deal with the question of power supply to act intelligently. He would like to know if Mr. Atkinson had figures giving the cost of power in Tasmania, as no figures appeared in the list that quoted typical cases of Australian charges. He understood that the prices charged in Tasmania were lower than any that he cited. The discussion on power problems that had taken place left the impression that what had been done towards solving the problem was not generally known. It was particularly inappropriate to criticise the State of New South Wales, for a publication entitled "The Power Resources of New South Wales" had been prepared by Mr. Wm. Corin, Chief Electrical Engineer of the New South Wales Public Works Department, and dealt with that matter in a more comprehensive way than had been attempted in any of the other States of the Commonwealth. That treatise showed how the water-power resources of the State might be linked up with the coal resources and the power made available for use where required. If members were not already acquainted with that publication they would find it to their advantage to study the matter it contained. The views on power questions that they had heard expressed suggested the advantage that would result if other institutes, experts in their particular subjects, were asked to contribute papers for reading before the Australasian Institute of Mining Engineers. In that way the mature views of specialists would be made available for the use of mining engineers.

Mr. Wm. Aplin said he came from a metalliferous mining area, where he found that the management contrived to get out the whole of the ore by using the square-set system of timbering. He would like to ask whether some application of that system, or some modification of it, could be adopted in coal mines, whereby all the coal could be recovered, perhaps, and the timber also at a later date.

Mr. Süssmilch said he should like to mention that in discussing this question it was not fair to make comparisons between coal-mines, where the mineral was worth a few shillings per ton, and metalliferous mines, where the ore was worth pounds per ton. Methods used in metal mines would be too costly in a coal-mine; but that did not mean that it was not possible to devise some method of taking out a much greater quantity of coal than was done now.

Mr. H. Herman said that the conservation of national resources, as Mr. Poole had already told them, had been a matter of the gravest consideration to the United States Federal Government for some time past. Forestry had received particular attention, and he thought the conservation of coal also. But there was a very strong feeling in that country that the national resources, which were not replaceable, were in the hands of the present generation as trustees, to be used with every precaution that nothing should be wasted, and that there should be no vandalism that would deprive future generations of their just due. He would like to know from Mr. Atkinson if anything had been done by the State of New South Wales to ensure that the abandonment of coal should not be pushed to too great an extent. As chairman, he thought it due to Mr. Atkinson to say that all the visiting members of the Institute, and those who came over with them, felt that the paper was an admirable descriptive summary of the district they were to inspect.

Mr. Atkinson, in reply, said: With regard to the question of the conservation of coal, and the remarks by Mr. Süssmilch, Mr. Ward, and Mr. Poole, he should like to give some figures with reference to the coal worked from the Delta collieries, all of which were now abandoned. They comprised Hetton, Stockton, Wickham,

and Bullock Island, and all the smaller collieries in the neighbourhood of Ferndale. Over an area which those collieries held of 11,230 acres, it was only fair to say that a considerable proportion was under the ocean. There had been obtained from that area 10,992,081 tons—that is, taking the outputs from the birth of the collieries to their close. The above acreage gave an area of practically 19 sq. miles, or a yield of 978 tons per acre. Of course, in those collieries, as Mr. Süssmilch remarked, it was necessary to leave considerable quantities of coal, on account of the workings being under water, under public buildings, under railways, and so on. But it went to show how much coal had been lost. for, calculating a seam 10 ft. thick over that area, it would have yielded, if wholly extracted, more than 10,000 tons per acre. He did not say that it would have been wise to have tried to extract more in that particular area. In Stockton, Hetton, and Wickham and Bullock Island, none of the pillars were touched at all. In regard to ordinarily thick seams in any district where it was not necessary to leave coal for the protection of public works, railways, or buildings, and the coal could be worked out, probably 95 % of the coal was recoverable, whether it be taken out by longwall or the bord and pillar system. At Maitland, where there were very thick seams, a very difficult problem came in. There the seam ran up to 30 ft. in thickness, and there was no doubt that if the metalliferous method of filling and timbering could be carried out, that would be the solution of the problem of getting the largest quantity of coal. But, as Mr. Süssmilch put it, coal was worth only a few shillings per ton, whereas in metalliferous mines the ore was worth pounds per ton. Another question that arose in connection with the working of thick seams was the fact that the best of the coal was on the floor, and there was a general tendency to go for the best. It must be remembered, also, that the top coal was associated with impurities which were likely to cause trouble. He did not know if it would interest members to see a plan of the scheme suggested before the Royal Commission on the winning of the thick seam at Pelaw Main. (Plan exhibited.) There the seam was somewhat different to the seam at Aberdare, as the whole 18 to 20 ft. from top to bottom

was practically clean coal. His idea in giving evidence before that Commission on the method of winning the greatest percentage of the coal was to set it out in panels, to work out the top 8 or 9 ft. first both in the bords and in the pillars, taking the latter out entirely, and then let the roof down. Then, when the area had subsided, go in and take out the bottom coal. The greatest practical objection to that was that the roof falling in the first place might leave a very difficult roof for the second working; and to some extent that might be so, but it could be obviated by leaving a coal roof in the working of the bottom part. That system had not been adopted, although it received considerable support from some of the managers. The question of the thick seam in Aberdare colliery was a different problem altogether, inasmuch as the top part of the seam had so many impurities that there was a natural desire to take the best coal first. The question was, then, how to get the top out. As he said before, the best solution would be to hydraulicly stow the workings, but the question of cost came in, and there was no suitable material. It would be observed that there were no dumps on the colliery sites of suitable refuse that could be availed of for filling the workings. Mr. Poole made reference to the difference in metalliferous mines and coal mines in the matter of ventilation. No doubt that arose very largely from the fact that in coal mines it was part of the general scheme to provide for ventilation, because of the liability to inflammable gas, which did not occur ordinarily in metalliferous mines. But he thought that fans had been used with success in some metalliferous mines, and they could be used with advantage to a still greater extent. As to the waste in the making of coke, he fully endorsed what Mr. Poole said, and no doubt the change from beehive to rectangular ovens would be beneficial in every way, giving greater production of coke and providing for the use of the waste gases. He had no doubt that coke-makers had realized the benefits of by-products ovens, and, when things became normal again, they could erect more plants of that kind, and make use of the gas. Of course, they might utilize the gas now at very little expense. There was one coking plant on the South Coast, at Corrimal, Balgownie, where they utilized the whole of the waste

gases to drive the steam plant which generated the electricity for the colliery. Mr. Morison made some reference to bord and pillar *versus* longwall. As he said, there was only one colliery in the North which worked on the longwall system, and that was Stockton-Borehole, near Cockle Creek, where the seam was from 3 ft. 6 in. to 4 ft. thick. He had no doubt that the system could be extended to advantage in, perhaps, some districts of the Borehole seam where it did not exceed 6 ft. or so. One of the difficulties in the way was the conservatism of the miners in regard to methods; they did not care about changing. No doubt they recovered rather more mineral by the longwall system than by the bord and pillar system, although in well-conducted bord and pillar collieries they were getting out 95 % of the whole of the coal in a reasonably thick seam of 8 ft. to 10 ft. With reference to the cost of electric power, which Mr. Stephenson spoke of, all sorts of information from the colliery people could be got except information as to costs. Then they close up like an oyster, and he had not tried to get costs from the colliery owners in the matter of electric plants, because he knew their reluctance to give them. Bellambi Co. supplied a number of people, and it also supplied electricity for lighting to the local council. That information should be available; but it was very difficult to tackle the colliery people on the question of costs. With regard to the figures of Mr. Corin, he thought the omission about Tasmania had been accidental. No doubt members could get the costs out of Mr. Corin's paper.

Mr. C. L. Garland said he knew one case where electric power was delivered at one-eighth of a penny per unit. That was in Tasmania, from water power.

Mr. Atkinson said the cost quoted by Mr. Garland was a great deal less than any figures he had quoted. With regard to the use of the square-set system, he thought it was really a question of cost. In a seam like that at Maitland, by adopting the square system of timbering, they could work the whole seam; but then would come the difficulty of mixing the better part of the bottom seam with the poorer portions of the upper seam, and the liability to spontaneous combustion. In that connection he might say that in one

colliery he knew there were at least 20 districts sealed off because spontaneous combustion had taken place. With regard to the general question raised by Mr. Herman—as to the conservation of minerals, including coal—personally he would like to see something done in that matter, but he did not see how it could be brought about. He thought the Council of this Institute could give very material help in directing some such inquiry from the Federal and State Governments. He had no doubt, also, that a great deal could be done as between the members of the Northern Engineering Institute and the Australasian Institute of Mining Engineers, with the assistance of the colliery managers and the Mines Department, but it was a matter which required consideration. He would suggest that the Council of the Australasian Institute of Mining Engineers give it consideration.

Mr. Atkinson (by letter):—The percentage of coal left in the mine referred to by the chairman was, in Crown leases, a matter which was governed by the conditions under which the lease was issued. Those conditions. which did not apply to privately-owned mines, specified that where the "pillar and stall" system of working was adopted the percentage of coal to be left in the pillars during construction of the bords, headings, drives, or other workings shall be 50 % up to 200 ft., 50 % to 60 % from 200 ft. to 500 ft., 60 % to 70 % from 500 ft. to 1000 ft., 70 % to 85 % from 1000 ft. to 2000 ft. In the determination of the dimensions of bords, cut-throughs, headings, crosscuts, and pillars, the following conditions applied:—Up to a depth of 200 ft. the bords must not exceed 6 yd. in width, the cut-throughs, headings, and crosscuts 4 yd., and the pillars must not be less than 8 yd. in width; from 200 ft. to 500 ft. the bords must not exceed 6 yd. in width, the cut-throughs, headings, and crosscuts 4 yd., and the pillars not less than 12 yd.; from 500 ft. to 1000 ft. the bords must not exceed 6 yd. in width, the cut-throughs, headings, and crosscuts 4 yd., and pillars not less than 22 yd.; from 1000 ft. to 2000 ft. the bords must not exceed 6 yd. in width, the cut-throughs, headings, and crosscuts 4 yd., and the pillars not less than 114 yd. The pillars may be subsequently removed unless the Secretary for Mines otherwise directs.

MANUFACTURE OF CEMENT FROM BLAST-FURNACE SLAG.

By Wm. Poole.

The successful establishment of iron blast-furnace plants at Newcastle and Lithgow naturally invites attention to the economic utilization of the various products and by-products arising out of the industry.

The general similarity in composition between Portland cement and iron blast-furnace slag very early attracted attention both in the cement and iron-smelting industries.

Probably the first use made of blast-furnace slag in the cement industry was not of an honourable nature—viz., to use an almost worthless and cumbersome by-product as a not readily detectable adulterant in Portland cement, which was at that time very costly to manufacture.

The astonishing discovery was made that in many cases the adulterated cement was stronger than the original unadulterated article. It was found that chilled blast-furnace slag introduced in moderate quantity and finely ground with the cement clinker did not injure, but usually improved, the quality of the resulting cement. This mode of manufacture is recognized, especially in Germany, as a legitimate branch of the cement-making industry.

The use of slag for the manufacture of both slag cement and Portland cement has assumed very large proportions both in U.S.A. and Europe—so much so that in the former country plants not well situated and equipped for cheaply making cement from clay and limestone are being forced to close down.

Slags from other than iron blast-furnaces, together with some of the latter, are not suitable for cement-making. All slags which disintegrate and fall into powder are wholly unfitted for cement-making. Those highly charged with mineral oxide compounds

[This paper is separately bound, and may be, is so desired, detached complete from this number.]

of sulphur, phosphorus, and large proportions of magnesia should also be at once rejected. Throughout the rest of the article iron blast-furnace slag will be simply referred to as slag.

Granulating the Slag.

It is necessary to suddenly chill hot molten slag in order to develop its hydraulicity and cementing power. It is well known that suddenly chilling any hot slag gives it physical and chemical properties materially differing from those which develop in unchilled slag—viz., brittle and soluble in acids instead of very tough and insoluble, or almost so, in acids. Unchilled slag is almost devoid of any hydraulicity or cementing power, besides being very difficult to pulverize. Chilling slag for use in cement-making is undertaken in different ways. In all cases it is essential that the slag shall be very hot, therefore the chilling must be done as near to the furnace as practicable.

The chief method of chilling molten slag is granulation in cold water. In this method the stream of hot slag is allowed to fall into a trough containing a rapid stream of cold water, preferably introduced as a jet directed with considerable force against the stream of molten slag. The physical effect is to cause the slag to break up into porous particles, usually called slag sand. This slag sand, as it leaves the vats, contains 15 % to 45 % (usually 30 % to 40 %) of adhering water. The expense of drying the slag sand is the chief disadvantage of water-granulated slag. This method is simple, cheap, and very effective, and is the one almost universally used. It also has a great chemical advantage—viz., that a very large proportion of the sulphur and alkalis contained in the slag are eliminated from it and carried off in the water.

Another method of granulation is that the stream of slag as it issues from the furnace is struck by a jet of high-pressure steam or air, which has the effect of blowing the slag into fine threads and globules, much the same as slag wool. In this form it has the advantage of being easily pulverized by grinding machinery, but has certain inconveniences, and has fallen into disuse.

Molten slag is also granulated by allowing the stream to fall upon inclined plates or revolving drums, which are kept cool. This method has been used to a moderate extent in Germany.

It is necessary to pass the granulated slag under a strong magnet in order to remove any particles of metallic iron.

Blast-furnace slag is used in making four classes of cement—

(1) Puzzolan, or ordinary slag cement, usually simply called slag cement.

(2) Slag Portland cement, which may be a true Portland cement.

(3) Iron cement or Eisen cement, which is a mixture of slag and ordinary Portland cement.

(4) Several special varieties of cement.

Slag Cement.

This is essentially a cement of the puzzolan type. A puzzolan material is one capable of forming a hydraulic cement on being simply mixed with lime. Puzzolan materials are largely made up of silica and alumina. Most puzzolan materials possess hydraulicity to a greater or less degree, but the addition of lime usually greatly increases their hydraulic power. Undoubtedly the most important puzzolan material is granulated slag. Some granulated slags high in lime possess, after fine-grinding, a high power of hydraulicity without the addition of slaked lime. The process of manufacture is very simple, and, in brief, is as follows :—

The dried granulated slag is mixed with a predetermined quantity of dry slaked lime and ground to an impalpable powder. It is then ready for use as cement. The slag sand, after being drained, still contains a large percentage of adhering water. This adhering water must be driven off until that remaining is less than 1 %. This drying is necessary for two reasons :—

(*a*) To prevent the water causing the mixed pure slag and slaked lime to combine and set and thus spoil it for use.

(*b*) To admit of the material being properly ground. Either dry or wet material (*i.e.*, wet with plenty of water) may be readily ground in suitable machines, but damp material only clogs a fine-dry-grinding machine.

Properly drying the material is therefore an essential feature of the process. Rotary driers are most commonly used, and it is found in good types that one pound of coal burned as fuel will evaporate 7 lb. of adhering water.

The limestone used for making the slaked lime is preferably a pure calcium-carbonate limestone, which, after burning and slaking, falls into a fine powder. The amount of magnesia present in the limestone must be very small, the admissible limit depending on the amount of magnesia present in the slag sand. The limestone is carefully burned in a kiln, drawn, cooled, and then slaked with water. The quantity of water to be added in slaking must be carefully gauged to slake the whole of the lime, but at the same time not to leave the slaked lime in a damp condition. Damp or wet slaked lime is not admissible for the same reasons as damp or wet slag sand. The slaked lime is then screened to remove any hard lumps. The latter may be of three types—viz., under-burned, over-burned, and properly burned but not slaked. The two former, though not desirable, are not harmful, but the last-mentioned is very injurious, as it causes "free lime" to be present in the finished cement. Free lime causes cement to "blow" after it has been made up into mortar or concrete, and thus causes the material to disintegrate.

A preliminary reduction of the dried granulated slag may be made in a ball mill, and the final grinding, after the requisite amount of slake lime has been added, made in a Fuller–Lehigh mill, tube mill, or other suitable fine dry grinder. The introduction of ball-peb and similar tube mills have, however, rendered a preliminary grinding of the slag unnecessary, as the whole reduction may be done in one operation.

A ball-peb tube mill is one divided into two or three separate compartments, the first compartment containing steel balls 3 to 5 in. in diameter, the second compartment steel balls 1½ in. to

2 in. in diameter, and the finishing compartment having $\frac{7}{8}$-in. ball-pebs; or the first compartment may have steel balls, and the finishing compartment be charged with short lengths of 1-in. diam. steel rods. These mills take feed 1 in. to 2 in. gauge, and finish off to a high degree of fineness. The slag sand being already fairly small, a two-compartment mill is sufficient for slag cement.

It is essential that slag cement be ground exceedingly fine; the finished product should not contain more than 3 % oversize on 100 mesh per linear inch sieve, nor more than 15 % on a 200-mesh sieve.

Lime-burning, slaking, and screening, as usually carried out, are slow, tedious, and expensive. It is essential for economical work that these operations be made as continuous as possible, and that the materials shall throughout be mechanically handled, and these are most readily attained by the use of producer gas-fired rotary limekilns, hydrating machines and mechanical screens, and the necessary bins, conveyers, elevators, &c. It is necessary for the materials fed to hydrating machines to be of small size. Shaft kilns, even of the best type, are of comparatively small capacity, require much attendant labour, have a high working cost, and do not work satisfactorily if charged with small material, as the latter chokes the draught. The rotary lime-kiln, on the other hand, is preferably fed with limestone crushed to 2-in. or smaller gauge, and has the following advantages—viz., continuous in action, economical in fuel, small amount of attendant labour, large capacity, and low working cost. The general outline of the process, with necessary bins, elevators, conveyers, &c., is as follows:—

The limestone from the quarry is passed through rock-breakers and rolls, and crushed to $\frac{1}{2}$-in. gauge. The broken material is fed continuously to a rotary kiln, the waste heat of which may be utilized for drying the slag sand. The calcined lime is fed in weighed batches to a hydrating machine, such as the Clyde hydrator, and slaked with a gauged amount of water. The material is thoroughly turned over and mixed until the action is complete, when it is mechanically discharged. A quantity of

1000 lb. of high-grade free lime requires 450 to 500 lb. of water for the operation, producing 1200 to 1225 lb. of hydrated lime, the rest of the water having been driven off as steam by the great heat developed during slaking. The hydrated lime, which should be perfectly dry, is fed to continuous-action screens, such as the Newaygo. The separated fine material is automatically weighed and mixed with the dried slag sand and ground into a finished product as cement.

Slags used in cement-making in Great Britain and Europe vary very considerably from each other in type and composition (see Table I.) American practice, however, aims at using slags which are much more uniform in character. The slags used by the Illinois Steel Company, Chicago, may be taken as typical of American slags used for making slag cement.

TABLE I.

Analyses of Slags Used for Making Slag Cements.

	Cleveland. %	Choindez, Switzerland. %	Dondeux. %	Bilboa, Spain. %	Port à Musson. %	Chicago. %
Lime ..	33–42	45–46	45–47	46–47	42	48–49
Silica ..	30–32	25–26	28	33–38	32	32–34
Alumina ..	25–28	23–25	18–19	10–13	22	12–16
Magnesia ..	3.5	1	2.5	1.4	4	2.3–2.6

The following analysis may be taken as illustrating the type of slag made at the Broken Hill Proprietary Co. Ltd. works at Newcastle :—

	%
CaO	39–40
SiO_2	30–32
Al_2O_3	22.5–24
FeO	.5
MgO	2.0
MnO_2	1.0
So_3, NaO_2, P_2O_3, etc. ..	1.75

This slag is higher in alumina but lower in lime than the type usually used in the U.S.A., but is very similar to many slags that have been used to make slag cement in Great Britain, France, Belgium, Germany, Spain, and Switzerland.

The amount of slaked lime that is added to the slag for grinding into cement naturally varies considerably with the type of slag used. The latter, being a by-product, its composition depends very largely upon that of the ores, fluxes, and ash of the fuel used in the blast furnaces.

The following are amounts of lime per 100 lb. of slag used at various places :—

	lb.
Choindez	40–45
Donjeux	40
Brunswick	33
Cleveland	33
Maryland Cement Co.	25
Another American plant ..	20
Seraing..	15 to 20
Bilboa	15
In slag bricks (U.S.A.)	10

Le Chatelier states that the hydraulic properties of granulated slag are due to the presence of a silico-alumino ferrite of calcium corresponding to the formula $3CaO$, Al_2O_3, $2SiO_2$. This compound appears also in Portland cements, but in them it is entirely inert owing to the slow cooling it has undergone. When, however, as in the case of granulated slags, it is cooled with great suddenness, it becomes an important hydraulic agent. When so cooled it is attacked by weak acids and also by alkalis. It combines particularly with hydrated lime, and in setting gives rise to silicates and aluminates of lime identical with those which are formed by entirely different reactions during the setting of Portland cement. It is upon this property that the manufacture of slag cement, which assumes daily greater importance, is based.

Chemists are still in enthusiastic disagreement as to the precise compounds formed and the reactions which take place both during the manufacture and setting of cement.

Slag cements differ widely in chemical composition from Portland cements mainly in the high percentage of Al_2O_3 and in their relatively low percentage of CaO, which, unless a larger

proportion than is ordinarily required has been added for some special purpose, need not exceed 46 % to 51 %, as against 58 % to 62 % CaO generally present in Portland cements.

The following analyses are given by Redgrave (*Proc. Inst. C.E.*, vol. cv.) as good examples :—

	Slag Cement. %	Portland Cement. %
CaO	46.53	60.59
SiO_2	24.10	22.23
Al_2O_3	16.3	7.22
FeO	0.93	4.32
MgO	2.08	1.10
CO_2	0.65	0.80
HO_2 combined with lime ..	6.45	1.05
SO_3	2.05	1.68
Insoluble and other ingredients ..	0.94	1.01

The average composition of a number of well-known British, European, and American slag cements is given in Table II.

TABLE II.

Analyses of Slag Cements.

	Cleveland. %	Choindez. %	Donjeux. %	Bilboa. %	Seraing. %	Chicago. %
Lime	45–47	54.0	49–51	49.77	49–55	50.3–51.5
Silica	24–26	19.5	23–25	30.56	27–32	27.2–29.8
Alumina ..	20–22	17.5	12–14	13.31	12–22	11.2–12.2
Magnesia ..	—	—	1.6–1.9	2.96	—	2.2–3.2
Combined water ..	—	—	5.6–7.8	—	—	2.6–5.3

It will be seen by comparing Tables I. and II. that, despite the apparently great variations in practice, the ultimate composition of very many finished slag cements falls within quite narrow limits, namely :—

	%
SiO_2	22 to 30
$Al_2O_3 + Fe_2O_3$	11 to 16
CaO	49 to 52
MgO	Less than 3
S	Less than 1
Loss on ignition ..	2.5 to 7.5

Nevertheless, many excellent British and other European slag cements have an appreciably lower percentage of CaO—for example, Cleveland cements and that quoted by Redgrave ; and some are materially higher in alumina—*e.g.*, Cleveland and Seraing. Kidd, in *Proc. Inst. C.E.*, vols. cv. and cvii., states that he had used Cleveland slag cements in marine work with most excellent results. Banks (*Iron and Steel Instit.*, 1905) claimed that slag cements made from Cleveland slags were the strongest cements known.

Slags containing a high percentage of lime after granulation and grinding, but without the addition of slaked lime, have a very high degree of hydraulicity and strength. Attempts have been made to produce slags approaching the Portland cement composition—*i.e.*, to make a slag which, when finely ground, would be a Portland cement. These attempts have not been successful, and were abandoned, very largely because producing slags abnormally high in lime interfered too much with the main function of the blast furnace—namely, as a producer of pig iron.

Denby and Lewis recently, before the Faraday Society, quoted a slag with a high lime-content as follows :—

	%
CaO	49
SiO_2	31
Al_2O_3	15

This slag is similar in composition to many finished slag cements.

The high lime was due to the necessity to remove sulphur from the metal, but some of the sulphur was removed from the slag during granulation. This slag, when ground, had a tensile strength of 430 lb. per sq. in. at 28 days.

The specific gravity of slag cement usually ranges from 2.7 to 2.9 as compared with 3.15, which may be considered a fair value for good Portland cement.

Slag cements are usually lighter in colour and slightly different in tint from Portland cement, the lightness in colour being largely due to the admixed slaked lime.

Slag cements normally set very slowly compared to Portland cements. The set of slag cements may be hastened by the

addition of puzzolanic materials. Of these, burned clay, certain active forms of silica, and slags high in Al_2O_3 are the cheapest and most generally used. Some slags used in making slag cement already contain a high percentage of Al_2O_3, and may not require any further regulation.

The most important method of regulation used with the low-percentage Al_2O_3 slag cements in the U.S.A. is the Whiting process. This process includes the use of caustic soda, caustic potash, sodium chloride, &c., added either as aqueous solution or in a dry state at some stage of the process of cement manufacture. Caustic soda 0.125 to 3 % may be added, depending upon the use for which the cement is intended. It is frequently added as an aqueous solution in slaking the freshly-burnt lime.

Slag cements differ from Portland cement in requiring no preliminary seasoning. Owing to the complete hydration of the lime used in slag cement and the inert character of the silicates present, little or no change can take place in the material, even when exposed to the atmosphere for a lengthy period. Slag cement protected from actual moisture undergoes no change whatever.

Slag cements fall below high-grade Portland cements in tensile strength, but good American slag cement develops sufficient strength to pass many American specifications for Portland cement. Tested neat, they do not approach Portland cements so nearly as tested in 2 to 1 and 3 to 1 mortars.

The following is the result of tests of some American slag cements :—*

	7 days.	28 days.
Neat Cement.—		
Tension	440–480 lb.	500–530 lb.
Compression	2050–2470 lb.	2830 „
1 *Cement to* 3 *Sand.*—		
Tension	145–170 lb.	200–243 lb.
Compression	486–930 „	938–1529 „

These results would satisfy the strength requirements in the standard Portland cement specification of many American public

* Eckel's "Cements, Limes, and Plasters."

bodies, but would not fulfil the requirements of the latest British standard specifications or the New South Wales Government specification.

Slag cements are deficient in resistance to mechanical wear, and are therefore not suitable for use in the surface of pavements and floors. They are well fitted for foundations and mass concrete generally, in which a high-grade strength is not necessary. They are deemed to be superior to Portland cements for making concrete to be used in or under either fresh or salt water. They are, therefore, specially suitable for use in connection with hydraulic, harbour, and marine works.

Mortar made from "fat limes" is, at its best, a very poor material as regards strength and setting. Such mortars, except on the surface, never set, and their hardness is little more than that due to merely drying out.

Hydraulic limes, which, on mixing into mortar or concrete set and harden, are practically not used in Australia.

Slow-setting slag cement could with great advantage as to quality replace "fat lime" in making mortar for ordinary building operations, and probably also at no increased cost in districts to which freight charges would be small.

A very large portion of the Portland cement is used in Australia under conditions where its very great strength and cost are quite disproportionate to the moderate requirements of the work. There is thus, at present, a very wide unfilled gap in quality, strength, and cost between the very indifferent "fat lime" mortar and that made from Portland cement, which could with advantage be filled by the use of a good cheap slag cement.

Portland Cement Made from Slag and Limestone.

Granulated slag is very extensively used in Britain, Europe, and more so in U.S.A., in the manufacture of Portland cement. The Universal Portland Cement Co. make a cement of this class, and have five mills, whose combined production is 12,000,000 barrels, or 2,000,000 tons, per year.

The mode of manufacture, chemical composition, and requirements for strength, soundness, &c., for Portland cement have been rigidly defined within narrow limits in most countries. The following particulars, from the British Standard Specification (1915), may be taken as closely representing the requirements for Portland cement in most countries. The cement shall be manufactured by intimately mixing together calcareous and argillaceous materials, burning them at a clinkering temperature, and grinding the resulting clinker so as to produce a cement capable of complying with the other requirements of the specification. No addition of any material shall be made after burning other than calcium sulphate or water, or both (added to control the time of set). The following percentages shall not be exceeded—viz., insoluble residue, 1.5 %; magnesia, 3 %; sulphuric anhydride, 2.75 %; and loss of ignition, 3 %. The proportion of lime to silica and alumina, when calculated (in chemical equivalents) by the formula $\frac{CaO}{SiO_2 + Al_2O_3}$ shall not be greater than 2.85 or less than 2.0.

It has long been established by law and custom in most countries that a cement made from blast-furnace slag and limestone so as to comply with standard requirements of method of manufacture, chemical composition, fineness, strength, soundness, specific gravity, &c., is legitimately a Portland cement, and may be sold as such.

Most cement makers aim at producing a cement having but a small range of composition for its components. Many blast-furnace slags contain a high percentage of alumina, which, when mixed with lime, would give a cement within the proportions of lime to silica and alumina given above, but considerably higher than they desire to have. The desired proportion is obtained by adding crushed quartz or silica sand to the mixture of slag and limestone. The method of manufacture is, briefly, as follows :—

The limestone is crushed to about 1½-in. gauge and dried in rotary driers, using coal as a fuel, or the waste heat from the kilns may

be used for this purpose. The limestone receives a preliminary grinding, and is delivered to hoppers above the scales. The slag is fed direct to driers, given a preliminary grinding, and delivered to hoppers above the scales. The limestone and slag are proportioned at the scales. The scales are preferably of the automatic electrically-operated type, interconnected, so that one cannot dump without the other. The mixed materials are very finely ground in a tube or other fine-grinding mill, then elevated to hoppers above the rotary kilns. In these kilns, using pulverized coal as fuel, the mixture attains a temperature of about 2500° Fahr., and gradually burns to a hard clinker. The clinker is seasoned for about 10 days, given a preliminary grinding, mixed with the amount of gypsum to regulate the setting, and then receives the finishing grinding in a tube or other mill. The resulting product is cement, which is carried to storage bins and bagged for distribution. There is reason to believe that portion of the foreign Portland cements imported before the war was of this origin, and readily came up to New South Wales Government standard tests.

Iron Portland Cement.

This cement, called Eisen Portland cement in Germany, is made of a finely-ground mixture of Portland cement and granulated slag, usually in the proportion of about 3 of cement to 1 of slag. As before mentioned, this class of cement probably was at first only a fraudulently adulterated Portland cement, but it is now extensively made and sold as a separate class of cement, for which special advantages are claimed. Its development as a separate branch of the cement industry rests on the theory of Dr. Michaelis, put forward in 1876—namely, that about one-third of the lime of Portland cement separates as crystalline calcium hydrates. This compound has no strengthening effect, and may have a harmful one. If this theory is correct it follows that it is desirable to add some substance which will unite with the free lime and convert it into calcium hydro-silicate or other useful compound, and thus raise the effective quantity of cement.

Ground granulated slag is used for this purpose, and may be added to Portland cement made from slag and limestone or to that made from clay and limestone. The slag is added to the Portland cement clinker during the final grinding, so that the resulting cement mixture is very fine ground and intimately mixed. Opinion is divided as to whether the addition is a benefit or merely an adulterant. There is no doubt that in many cases it produces an article which is sounder and stronger than the original cement. The addition of a small amount of suitable granulated slag to high-lime Portland cements would be beneficial as a safeguard against that bugbear of the danger of expansion due to "free lime."

This addition should be made after clinkering and before the final grinding, so that the resulting product is very intimately mixed. Standard specifications for Portland cement prohibit any such addition, and it could only be done at the express instruction of the user.

The specific gravity of iron Portland cement—namely about 3.0—is intermediate between that of slag cement and Portland cement. Iron Portland cement is received with a high degree of favour in the Continental countries of Europe.

The following * are comparative mortar tests made on ordinary Portland cement and on iron cement made from 75 parts of the foregoing and 25 parts of granulated slag :—

MORTAR—1 CEMENT TO 3 SAND.

Time of Test.	In Air.				In Water.			
	Tension.		Compression.		Tension.		Compression.	
	Cement.	Mixture.	Cement.	Mixture.	Cement.	Mix.	Cement.	Mix.
7 days ..	234	292	1321	1401	219	205	1208	1771
30 ,, ..	356	410	2089	2705	262	271	1553	2046
90 ,, ..	578	616	2884	4107	335	390	2007	3092

The following * are tests of (German) Eisen cement made at a time when the German specifications for Portland cement

* Dr. G. B. Waterhouse, "Utilization of Blast Furnace Slag," *Engineering Magazine*, vol. 37.

required the following strengths for 1 to 3 cement-sand mixtures at 28 days—viz., tension 227 lb., and compression 2270 lb. per sq. in. :—

Tension	390 lb. in air	320 lb. in water
Compression ..	3331 „ „ „	3192 „ „ „

The very high compression strength of iron cement makes it particularly suitable for special work, such as reinforced concrete.

Special Cements.

Probably the most important of these is that made by the Colloseus method.* This cement is now being made at a number of plants in Germany, Britain, and U.S.A. In this process basic blast-iron slag is granulated in a special device, using a limited amount of aqueous solution of alkaline salts. The special salts are intimately mixed with the slag and the latter chemically and physically changed, being a porous clinker easily powdered. The chief salt is magnesium sulphate (crude Epsom salts), used as a 5 % solution.

The stream of slag falls on a horizontal ribbed drum rotating at 650 r.p.m. Between the ribs are slots through which spurts the granulating solution. There is also a jet of solution just below the stream of slag. The slag is granulated as little pellets. Ungranulated slag is separated from the mass on a turn-table. Only so much solution is used that the granulated slag is perfectly dry after the operation. The slag is then treated as in the case of ordinary Portland cement clinker—*i.e.*, no further addition of any material is made except such as is customary to regulate the setting. The sulphur content of the slag should be low, and the amount of magnesia should be less than 3.5 to 4 %.

The cement is ground very fine, specific gravity 2.97 to 3.0. Time of set—initial, 18 to 20 minutes ; final, 35 to 45 minutes. This is a very quick-setting cement when compared to the ordinary slag cement.

* Dr. G. B. Waterhouse, *Engineering Magazine*, vol. 37.

The following* are results of tension tests of fresh cement and of cement which has been stored one month. Each test is the average of 10 samples :—

Neat Cement.—	In Water.		In Air.	
	Fresh Cement.	1 Month Stored Cement.	Fresh Cement.	Stored. Cement.
3 days	483 lb.	508 lb.	476 lb.	445 lb.
7 „	536 „	560 „	619 „	581 „
28 „	543 „	593 „	743 „	708 „
1 *to* 3 *Mortar.*—				
3 days	233 lb.	236 lb.	267 lb.	253 lb.
7 „	274 „	309 „	345 „	316 „
28 „	285 „	343 „	368 „	389 „

This cement is considered superior to Portland cement in that it contains no free lime, and therefore is free from the danger of expansion.

Another special cement is made by finely grinding granulated slag with a considerable quantity of plaster of Paris. This gives a quick-setting, hard cement.

Slag Bricks.

The slag-brick industry may be considered to be a specialized branch of the slag-cement industry, but a wider range of slags may be used. The manufacture includes bricks, pipes, and other special shapes, and the details of practice vary considerably in different works. The most usual method is to finely grind together 100 parts of dry granulated slag and 10 parts of slaked lime, giving what is really a slag cement of lower lime-content. A small amount of water is added to the material and mixed to a stiff pug and passed on to suitable brick or pipe-making machinery. The bricks or pipes are stacked to dry and harden before distributing for use. The hardening is sometimes hastened by treatment under the heat and pressure of steam. As before mentioned, some finely-ground granulated slags possess a high power of hydraulicity without the addition of slaked lime, and may be made directly into bricks.

* Dr. G. B. Waterhouse, *Engineering Magazine*, vol. 37.

Another important variation of process is to mix slag cement with fine slag sand which has been drained but not dried, there being sufficient water to pug the mixture before passing to the brick machines. Well-made slag bricks are stronger than clay bricks. Slag bricks are used for ordinary building purposes, but, as they are more refractory than red-clay bricks, they are of special service in the outer walls of furnaces and for chimney stacks.

It will be seen from the foregoing brief survey of the subject that a large variety of cements may be made from suitable basic granulated iron blast-furnace slags. It has been prophesied that in a few years nearly all cement will be made by some process from blast-furnace slag.

The writer is indebted to Mr. G. D. Delprat, general manager Broken Hill Proprietary Company Limited, for kind permission to use data in connection with the blast-furnace slags made at the Newcastle iron and steel works.

DISCUSSION.

Mr. G. Stephen Hart said, as Mr. Poole mentioned, chemists were still in "enthusiastic disagreement" as to why cements set and the chemical compounds formed, but microscopical examination showed optically different compounds named alit, belit, celit, and felit. A chilled slag differed physically from a slowly-cooled one, presumably on account of a different grouping of its atoms, as with steels cooled quickly and slowly; but to assert that slag cements on setting formed the same compounds as Portland cements seemed rather daring. It was not supported by their properties when set. The tests quoted illustrated the curious fact that in both neat and 1 to 3 mixtures, slag cements were only five times as strong in compression as in tension, whilst Portland cements were ten times as strong. The neat slag cement quoted gave a strength in compression of 2830 lb. in 28 days. The New South Wales standard for Portland cement mixed with three times its weight of sand was 2250 lb. after 28 days, and the best cements gave more than double that strength in a 1 to 3 mixture; still, there should be a use for slag cement where great strength

was not needed—for example, in taking the place of mortar, as suggested by Mr. Poole. It would have a more local market, as bagging, freight, etc., would be as great as on stronger Portland cement, which could be mixed with sand where used. For the manufacture of a true Portland cement the analysis of the Newcastle slag showed it to be too high in Al_2O_3 compared with SiO_2 for rotary-kiln practice, and mixing with siliceous material, as suggested, would tend to complicate the process. It was, therefore, mostly a question of costs. The danger of free lime in Portland cement was far less with modern rotary kilns than when old-fashioned stationary kilns were used. In those the whole charge was never properly burnt, and a gang of men had to be employed on the clinker heaps to sort out the good clinker from the bad. In cement one part of CaO could combine with 2.8 of SiO_2, but only with 1 of Al_2O_3; therefore a siliceous cement needed a much higher percentage of lime. The old stationary kilns could not burn a highly siliceous cement, but present-day rotary-kiln practice favoured that, and he (Mr. Hart) had no doubt that every Australasian cement carried a higher percentage of lime than the example quoted in the paper. Mr. W. A. Brown, in "The Portland Cement Industry," published in 1916, stated that in a good Portland cement the lime should be from 60 to 67 % and the silica 20 to 25 %. If one part MgO was taken as equal to 1.4 parts CaO, a New Zealand cement described in a paper presented to the Institute* contained CaO and MgO equivalent to 65 % of CaO and 25.9 % of SiO_2. With reference to the strength tests in that paper, it should be remembered that briquettes made differently would give different results. The British standard specifications insisted upon briquettes being patted down with a spatula weighing 11 oz. They also demanded an increase of strength of about 10 % between 7 and 28 days. New South Wales specifications used the Boehme hammer—a trip hammer weighing about 5 lb.—which, after 150 blows, was automatically stopped. Thus, any personal factor was minimized, but briquettes so made were relatively stronger after 7 days, and, to comply with B.S.S. requirements, briquettes should be made as the B.S.S. specified.

* Trans., Vol. XVI., p. 284.

Different cement tests were required by different Australian States, and even by different public departments in one State. That was most undesirable, as there was always the chance that one body would devise an unusual test which no cement could pass unless too bad for use, if judged by some other department's specifications.

Mr. A. S. Kenyon said with regard to Portland cement he did not think that engineers were going to relax their specifications, but rather the other way. Mr. Hart's candid admissions, that his company had always proved able to more than meet requirements made one inclined to stiffen them up. It was not a 10 % increase on the seven days' test, that was asked for; but that only 90 % of the set should occur during the first seven days, which was a very different thing. It was not that the engineer worried about the seven days' set, but that he wanted a 28 days' set. With regard to slag cement, he would like to ask Mr. Poole to add a word as to the possible amount of cement they were likely to obtain from those works, whether it would equal the compression test, and whether the quality would equal that of the ordinary quality of cement in use. In other words—What was the amount of commercial cement that might be made in that way in Australia?

Mr. Poole, in reply, said he was not aware that the Commonwealth Portland cement was as high as 64 % in lime. But, in speaking of free lime, he certainly did not include hydrated lime as free lime. Free lime was anhydrous calcium oxide (CaO). It was not contended that a slag cement was as good as high-class Portland cement; but it must not be forgotten that the cement made in New South Wales had grown up under, as far as he knew, the stiffest set of tests in the world. Those tests had been in vogue for quite a number of years, and cements that had grown up under them had to be very high-grade to pass. The result had been that public bodies, private engineers, and architects merely stipulated that the cement to be supplied must come up to the New South Wales Government specification. He thought the majority of engineers did not like a very high-lime cement,

because there was always a fear that it would be unsafe. No man wished to undertake an important piece of work with cement, even though it showed up well in laboratory tests, if it afterwards cracked or disintegration took place. He would prefer a cement of comparatively low-strength test, but absolutely sound in quality. As far as free lime was concerned, he did not think it was usual to test it at works. Yet certain well-known tests could be carried out at works to show the general soundness of a cement. With regard to the carrying of cement in bulk, he believed it was coming into vogue in the United States, where it was being carried, like other materials, in bulk, in proper trucks. In and around Newcastle it could be carried in bulk; but under the present system of railway trucks it would not be possible to ship it in bulk to other parts of New South Wales. They had one of the most antiquated systems of trucking in the world. When two such world-wide authorities as Michaelis and Le Chatelier disagreed as to the chemical reactions which took place during the setting of cement, it was not for those who were not expert chemists to enter into the fray. He thought that Newcastle slag could be made into a good straight-out Portland cement. He was not giving secrets away when he said that it had been examined for that purpose by one of the most progressive cement companies in Australia, and that they were quite satisfied. As to the quantity of slag cement that may be available, he could inform Mr. Kenyon that there was a company in formation; but whether they would make a straight-out slag cement was another question. The Portland cement man did not look favourably on slag cement. It was only rarely that the full strength of Portland cement was fully utilized. As a matter of fact, outside of reinforced concrete, the great strength of Portland cement was rarely utilized. A cement of much less strength would suffice for most purposes. The output of slag cement would depend upon the output of slag from the furnace at Newcastle. There was one blast furnace now in use, and shortly a second would come into commission. The amount of slag available would be practically the quantity the furnaces produced, less what the company may require for their own particular purposes in the steel works.

AN IMPROVED METHOD OF DUMPING SPOIL.

BY GEO. H. BROOME.

About twelve months ago, owing to the increasing quantity of stone and dirt being drawn from the Victorian State Coal Mine, due to the large amount of dead work below ground, cutting faults, etc., and to the increasing quantity of banded coal being worked, the writer was forced to consider the question of economy in handling the spoil at the surface.

The method in operation at the time was to run out level dumps from the tipping floor of the heapstead, or brace, and to tip most of the skips of stone in tipplers at the ends of the dumps, the remainder of the skips being side-tipped to widen the dumps.

The method, whilst quite satisfactory for dealing with a few skips of stone, was found to be costly as the dumps extended, and the number of skips to be dealt with increased from 300 to 400 per day of two shifts; therefore, in order to expedite the work and cheapen its cost, the writer devised an improved method which may be described as follows:—

(1) The stone is tipped into a hopper car which holds about 10 skips.

(2) The hopper car is hauled up an inclined dump by means of an electric winch.

(3) The spoil is dumped from the car forwards or to either side, as required.

(4) The car is returned to the starting point for a further load.

Plate I., Fig. 1 gives an idea of the construction of the hopper car. In the illustration the car is in position for tipping to one side. The body of the car is supported on a ball race on the under carriage, and it can be swung round to tip in any required direction. The bottom of the hopper is extended to form a 4 ft. lip,

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which shoots the spoil well out, forming a bank of from 14 ft. to 15 ft. in width; but when the dump has been carried out to the desired distance, it is obvious that by side-dumping it can be extended laterally till a large sector of a circle is covered.

The end of the dump at the State Coal Mine is now about 60 ft. in height; the top width is about 40 ft.; and the bottom width about 160 ft.

Fig. 1 illustrates the front and side views of the car and gives its overall dimensions. The frame of the hopper is constructed of $3\frac{1}{2}$-in. by $3\frac{1}{2}$-in. by $\frac{3}{8}$-in. angle irons, its sides and bottom are formed of 2-in. planking; the sides being lined with $\frac{3}{16}$-in. steel plates, and the bottom with $\frac{1}{4}$-in. plate.

No trestles have been used in the dump. A pair of rails at the end of the dump is laid on timber balks which, with the rails attached, are hauled forward by the haulage winch when it is necessary to extend the track, and a short pair of rails is laid behind; thus the rails are made to overhang the end of the dump until the dump again overtakes them.

Plate I., Fig. 2 shows the car in the act of discharging at the end of the dump, it also shows the staging supporting the return wheel for the haulage rope. The winch is placed close by the point where the car is loaded. Two men tip the skips into the hopper car, and when it is filled one of them operates the winch, and the other walks out with the car and releases the door at the required place. These two men are now easily handling 250 skips of stone per shift, whereas, before the introduction of the improved method, five men were needed to deal with a lesser quantity of spoil.

Arnall & Jackson, Printers to Ins. I.M.E.

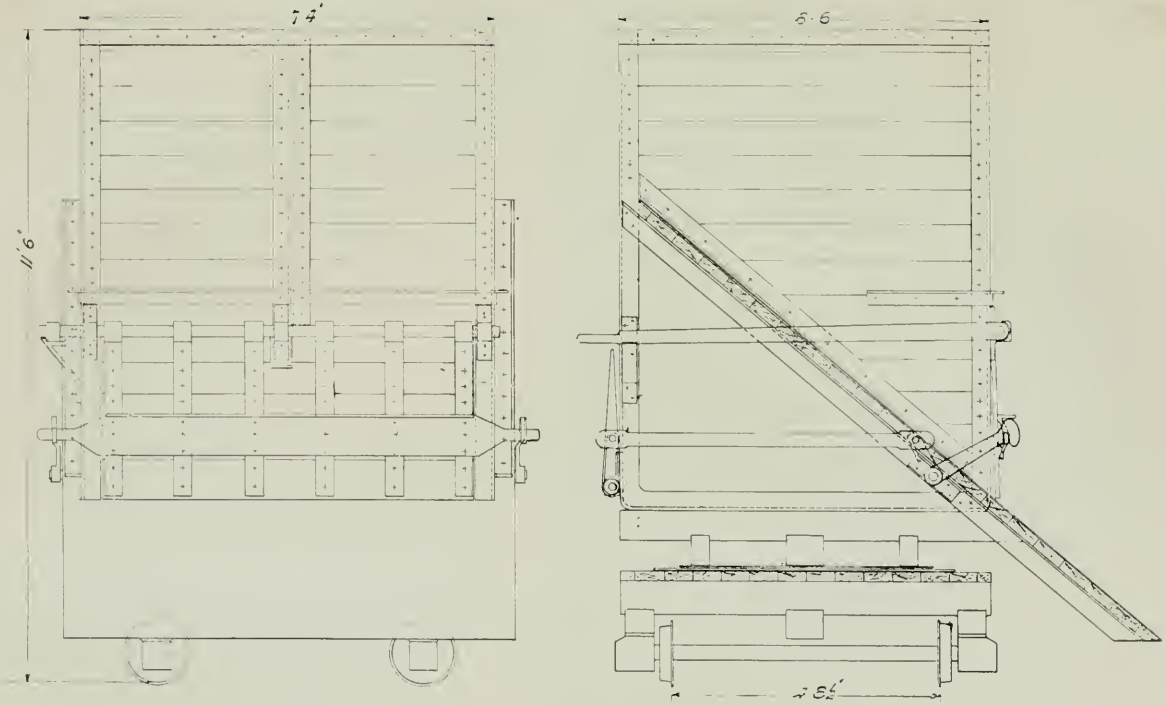

Fig. 1.
Victorian State Coal Mine.
Hopper Car

FIG. 1.
Hopper Car.

FIG. 2.
Car and Staging.

EXPERIMENTAL ELECTRIC FURNACE.

By S. R. Mitchell.

The furnace described in this paper was installed and has been used by the writer for the melting of rich gold-bearing material, and has given complete satisfaction. It may, therefore, prove of interest to other metallurgists who are faced with a similar problem. A furnace of this type should be most suitable for the reduction of "cyanide precipitate," "charcoal ash," "anode sludge," &c. Formerly the melting was done in fire-clay crucibles, using coke or crude oil as fuel, but this method is costly, slow, and unsatisfactory. A small 18-in. water-jacketed blast-furnace was also tried on this material after briquetting it, but was discarded in favour of the electric furnace.

The furnace may be described as a simple form of the Heroult resistance furnace, with an adjustable upper electrode and a fixed bottom electrode. This is in accordance with Stansfield's classification of electric furnaces. The heating is mostly due to the resistance offered the current by the molten slag.

The melting chamber consists of a steel drum 14 in. in diameter and 21 in. high, and is lined with silica bricks specially made to fit the shell. The internal diameter is 6 in. The bricks contain 92 % silica, are made from calcined quartzite bonded with fire-clay, and are similar in composition to those used for lining steel converters. They are set in a mixture of finely-ground quartzite and clay, and well dried out.

The shell is bolted to a steel plate, which forms the decking of a truck running on rails, so that the furnace can be moved under a hood for carrying off the fumes. A cast-iron slag spout is bolted to the shell below the tapping hole, which is 6 in. from the bottom of the shell. Opposite this another hole $\frac{3}{4}$ in. in diameter is drilled through the shell and lining for the passage of the lower

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cable. This is made up of four strands of No. 4 copper wire, about 24 in. long, and sweated into a "lug" at one end. The other ends are spread out near the bottom of the crucible, and are tamped round with a hot mixture of crushed graphite and distilled tar and covered for about 3 in. This acts as the lower electrode.

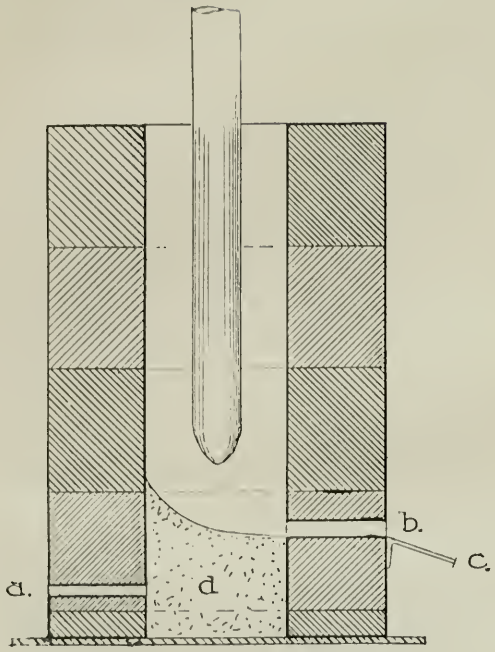
The electrical installation consists of a 20 k.v.a. transformer, immersed in oil, and supplied by single-phase current at 400 volts. The board is fitted with fuses, knife-switch, ammeter, and voltmeter.

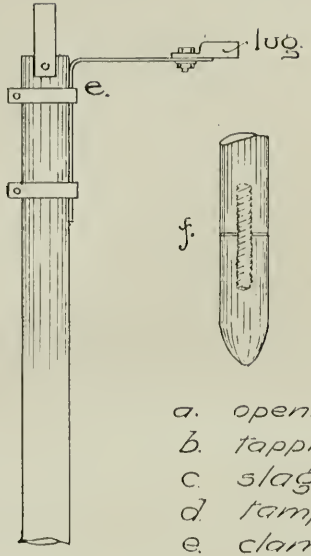
From the secondary side a cable connects direct to the furnace bottom. From the board another cable connects to the fixed plate of a water rheostat. This is simply a wooden trough 24 in. square and 24 in. deep, with two steel plates 21 in. by 18 in. One is movable backwards or forwards, and the other is fixed. The movable plate is connected by a flexible cable to the upper electrode of the furnace. The rheostat is only used in starting operations by cutting down the current, and can be thrown out of circuit.

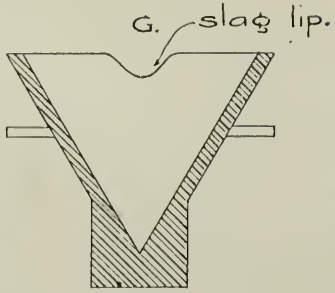
The upper electrode is of 2-in. round Acheson graphite, suspended over the furnace by a 3/16-in. flexible steel cable running over pulleys, and is raised or lowered by means of a small worm and wheel.

The electrode holder is a strip of copper 2 in. wide, $\frac{1}{8}$ in. thick, and 18 in. long. It is bent at right-angles, and clamped for 6 or 8 in. down the side of the electrode. A $\frac{3}{8}$-in. stud is also screwed through the holder and into the graphite to prevent slipping. The other end of the holder has a hole drilled through it so that the lug on the cable can be bolted to it. This seems a very crude type of holder, but answers better than several others tried. A fire-brick serves to keep the electrode central whilst the furnace is operating.

The material which is melted is finely divided, and varies greatly in composition. It contains from 20 % to 60 % of silica, together with iron oxides, alumina, &c. Air-slaked lime and a very small proportion of borax are the only fluxes used. A little sulphur or







a. opening for lower cable.
b. tapping hole.
c. slag lip.
d. ramped in lower electrode.
e. clamp for electrode.
f. method of joining electrode.
G. section of slag pot.

FIG. 1.

galena is sometimes added to form a matte with any iron that may be reduced. No particular type of slag is or can be adhered to. If it is too basic the linings cut out rapidly. The higher the percentage of silica that can be used the better, as this means longer life to the linings, a greater resistance to the current, and a higher temperature. As the temperature attained is very great, the question of fusible slags is not a difficult one. Litharge and old cupel bottoms, together with sufficient coke dust to reduce the lead, are added to the charge to supply the carrier for the valuable metals. The amount of lead used depends on the richness of the charge; usually 12 % to 15 % is sufficient.

On starting the furnace the rheostat plates are separated, the power switched on, the upper electrode is lowered until a steady arc is obtained, and a pound or two of slag is thrown into the crucible. When this melts, the crucible is filled with dampened charge. As the charge melts and the resistance becomes steady, the load in amperes is increased by adjusting the electrode until 225 amp. show on the meter, the voltage being about 80.

The furnace top is open, but the electrode is kept fairly cool by the unmelted charge surrounding it. This also protects it from excessive oxidation. Gases and steam are evolved, and cause a small amount of dusting. The furnace is surrounded by a frame lined with iron and provided with a flue for carrying off the fumes. All dust is swept up and returned to the furnace.

As the charge melts and subsides further material is fed in until the crucible is nearly full of molten slag. In tapping, a steel bar is driven through the tapping hole, and the molten slag and metal are run into a conical mould, provided with a lip. This acts as a settler or forehearth, and the excess slag overflows and is caught in other moulds, similarly shaped. The crucible is not completely emptied except at the end of the day. There is usually no difficulty in tapping, and the slag runs out white hot and very fluid. The separation of the values is good, considering the richness of the material melted. As an example, 231 lb. of material, containing 69 oz. 4 dwt. 12 gr. of gold, equal to 671.3 oz. per ton, gave slags worth 7 oz. per ton.

The amount of energy used per lb. of charge averages 1.1 kw., and the quantity melted per 8 hours varies between 60 and 100 lb. Slags are melted at a much faster rate. The silica-brick linings last from 36 to 72 hours.

Electrodes are joined by drilling and tapping $\frac{3}{4}$-in. holes and screwing in a threaded iron dowel, 4 in. long. Before tightening up, a paste of graphite and tar is spread on the ends. When screwed together, good electrical contact is ensured. By this means very little of the electrode has to be discarded.

The metallic bottoms separated from the slag are placed in fire-clay crucibles and heated to liquate the lead bullion, which is poured off. The residue is refined by stirring in nitre. This metal and the leady bullion is subsequently cupelled in a small gas-fired cupel furnace. The resulting rich bullion is treated chemically to separate the gold, silver, and, if present, platinum.

The advantages of electric melting are many. There is practically no danger from electric shock, no skilled labour is required for handling, the melting is rapid, and the temperature is ample and under perfect control.

Based on results obtained from this small furnace, a much larger one is to be installed.

References.

"The Electric Furnace." A. Stansfield, D.Sc. 1914.

"The Electric Furnace in Metallurgical Work." Bulletin 77, Bureau of Mines, U.S.A. D. A. Lyon, R. M. Keeney, and J. S. Cullen.

"Electric Furnace at Lluvia de Ora." H. R. Conklin. *Engineering and Mining*, July, 1912, p. 1189.

DISCUSSION.

Mr. W. Poole said Mr. Mitchell had done well to bring that subject before the Institute, because it was a very important class of work that had come to stay in Australia. In addition to the works he mentioned there was also a company in Sydney—namely, the Australian Electric Steel Ltd., which had been

making steel castings for over two years, and had been doing very satisfactory work. An engineering firm in Newcastle was also about to instal an electric furnace for making steel castings. Experimental work had been made on zinc-sulphide ore from Queensland. The production of metallic zinc in an electric furnace from fully roasted sulphide ore was now a successful process, and a plant had been erected in Tasmania for that purpose. The experimental work carried out on the Queensland ore was an attempt to commercially produce zinc direct from the unroasted sulphide ore. It was reported that a British company was about to instal works in North Queensland for the electrical-furnace reduction of wolfram and molybdenite ore.

Mr. Mitchell, in reply, said one reason why these industries were not more heard of was the cost of current. Taking the minimum rate of the Melbourne Electric Supply Co., which supplied current at .66 of a penny, that worked out at £24 per h.p. per year. He understood that the lowest rate of the hydro-electric plants in Tasmania was .067 of a penny per unit, which worked out at a little over £2 per h.p. per year. That showed the disadvantage under which they laboured in starting such works on the mainland.

SOME NOTES ON THE GEOLOGY OF STANNARY HILLS, NORTH QUEENSLAND.

By G. B. Hope.

The following notes were accumulated during the years 1905 to 1911, when the writer was employed at Stannary Hills. The writer's duty took him over the underground workings daily. In odd moments the geology of the surrounding country was worked out. As the time for this purpose was limited, many interesting points had to be left untouched. The faulting system in the mines was of such a puzzling character that it seemed as if the geology of the surrounding district might throw some light on it. Dr. Jack, in 1907, reported on these mines for the shareholders, but came to no definite conclusions. Unfortunately, the writer has not had access to this report for many years. At the time of his visit the larger developments in the Ivanhoe and Kitchener ore-bodies (see Fig 1, B2) were only being opened up. Mr. H. Herman mentions Stannary Hills on p. 320, *Proceedings Aust Inst. M.E.*, new series, No. 14, and on p. 326 expresses the opinion that the pipe or joint-veins (as at Irvinebank and Stannary Hills) were more valuable to follow than lodes in the granite in that district.

Geology of District.

The main feature of the area mapped is a band of altered sedimentary rocks which carry no fossils. It is a mile wide, and consists of a hard band of greywackes 200 to 300 yds. wide, flanked on both sides by contorted shales, which become more micaceous as the granite-area to the east is approached.

The strata have a general strike of N. 30° W., with a steep westerly dip. A large area of dacite and acid intrusive rocks occurs to the west of this band. The outstanding feature of the district is a fault which cuts the sedimentary series in two, to the

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east of the town of Stannary Hills. Its strike is N. 15° E. No definite evidence of its hade was observed. The line of the fault is marked by later intrusions of eruptive rocks.

The dacites contain a dyke of quartz-porphyry (as shown in Fig. 1, C3 D3) running more or less parallel to the sedimentary series. The quartz-porphyry contains a dyke of a rock of rhyolitic texture near the fault-line (Fig. 1, C3). The eastern area of sedimentaries contains an intrusive mass of rhyolitic character which, in one creek-section, shows columnar structure. It, again, at the Divide (Fig. 1, B4), contained a small dyke of a quartz-porphyry.

The granite-area near the contacts was more or less altered to greisen, &c., and in the area to the east of the fault contained granophyres and other varieties of acid rocks. Normally it is a biotite-granite. The line of the fault from the dacites to Dr. Brown's (Fig. 1, A4) was masked by detritus from the granite hills.

It will be noticed that the dacite separates the eastern sedimentary area from the granite along part of the fault-line. Outliers of granite occur south of the western sedimentary area (Fig. 1, D2 and D3).

Each formation has its own topographical features. The granite-area is a bold, high range. The sedimentaries, on its flanks, have the softer rocks scoured out to form the main water-channels, and are at a lower level. The igneous intrusives form boulder-strewn ridges, more or less undulating, except where cut by creeks, in which case the creek is a rocky gorge with steep, precipitous banks. The eastern sedimentary area is undulating country, owing to the water being held up where the creek crosses the harder intrusive rocks (Fig. 1, B3).

SEQUENCE OF FORMATIONS.

The sedimentary series is the oldest, and belongs probably to one of the older Palæozoic formations. The writer heard a rumour that between Irvinebank and Herberton Devonian fossils had been found, but was not able to verify it. The granite tilted

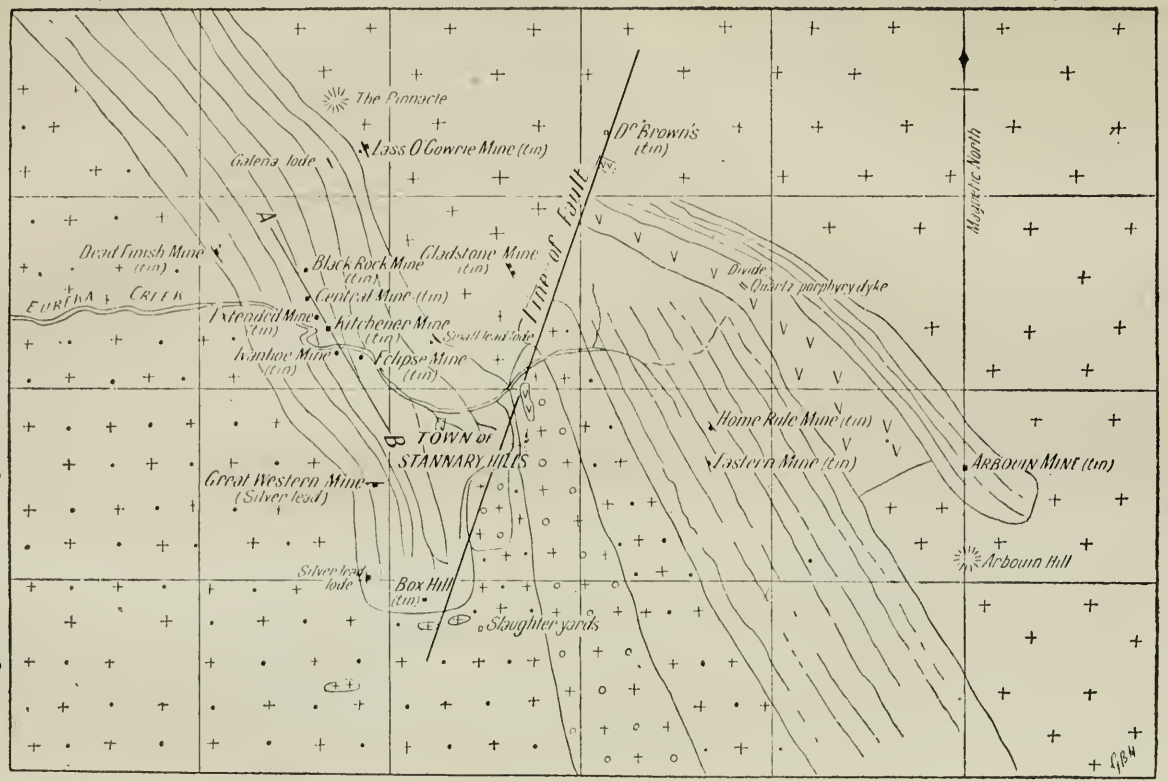

FIG. 1.
SCALE: 1 IN. = 1 MILE.

and contorted the sedimentary rocks, and probably bent them, as shown in the map (Fig. 1, B2), and introduced the mineral-bearing solutions. The area B2 (of Fig. 1) received most attention from these solutions.

At a later period the fault disturbed the country. Following this event a tremendous eruption of dacite occurred, into which quartz-porphyry and rhyolite intruded.

The granite-area (Fig. 1, B6, B5) contains acid eruptives, including granophyres and very few minerals, whereas the area to the west of the fault is highly mineralized. Further examinations are needed in this locality.

DESCRIPTION OF ROCKS.

The *greywacke* is of two types—(*a*) coarse and very hard, (*b*) fine-grained and hard. Both consist of grains of quartz and felspars, with sericite and similar minerals developed in the felspars. The quartz shows strain-structures. The coarse variety resembles a quartzite in appearance and hardness. The fine-grained variety near the lode becomes charged with chlorite, and, as a matter of fact, merges into the chloritic lode-material. Where not near the lode it has a dark colour and a very fine texture.

The *quartz-porphyry* contains large phenocrysts of quartz and sanidine in a ground-mass of smaller phenocrysts set in a glass. Mica is present in small quantities. The ground-mass shows no flow-structure.

The *rhyolite* contains quartz and sanidine phenocrysts on a glassy ground-mass, showing slight signs of flow. It is not porphyritic.

The *dacite* is a dark rock containing orthoclase, plagioclase, quartz, and mica, set in a glassy ground-mass, with well-marked flow-structure.

The *granite* is normally a biotite-granite with large crystals. Graphic granites, granophyres, and other varieties are to be found. Aplites and graphic granites occur near contacts and lodes in the granite.

OCCURRENCE OF LODE-FORMATIONS.

The lode-formations are restricted to the granite and sedimentary rocks, and they are only of commercial value in a restricted area.

Lodes containing cassiterite, galena (with silver), copper, wolfram, and antimony are to be seen, but only the first-named occur in any quantity. The lead lodes are next in importance, but they are small, and pinch out, as a rule, below the oxidized zone. Lead lodes occur on the junction of the western sedimentary area on both flanks, as shown on the map.

Copper, wolfram, lead, and antimony lodes occur in veins running N. 30° W. in the granite-area, W. and N.W. of the Lass o' Gowrie mine (Fig. 1, A2).

The granite-area east of the fault contains few if any lodes.

The tin lodes in the granite-area are of two types, but only two lodes are of any consequence—*i.e.*, the Lass o' Gowrie and Gladstone. The former is a rich, thin fissure-vein containing cassiterite, fluorspar, and white mica in greisen. The Gladstone is more patchy, but larger, and very rich in cassiterite. Arsenical pyrites also occurs in these lodes. Granite altered to quartz and impregnated with cassiterite occurs at Dr. Brown's (Fig. 1, A4).

The western sedimentary area is the chief tin-producer, and contains lodes of two types—*i.e.*, (*a*) fissure-lodes in the shales and near the junction with the igneous rocks, (*b*) irregular ore-bodies in the central greywackes.

The Dead Finish is of the first type (Fig. 1, B2). Areas (Fig. 1, C2 and C3) contain numerous small lodes of low value in tin.

The eastern sedimentary area contains only two lodes of proved value, and contains, relatively speaking, few lode-formations. The Eastern (Fig. 1, C4) is a fissure-lode, with lenses of cassiterite and sulphides. The Arbouin (Fig. 1, C6) is a large low-grade deposit surrounded by smaller and richer fissures. Little work was done here except at the surface.

The area of sedimentary rock running N.W. from the Arbouin contains numerous oxidized outcrops, which, to date, have not been of much value.

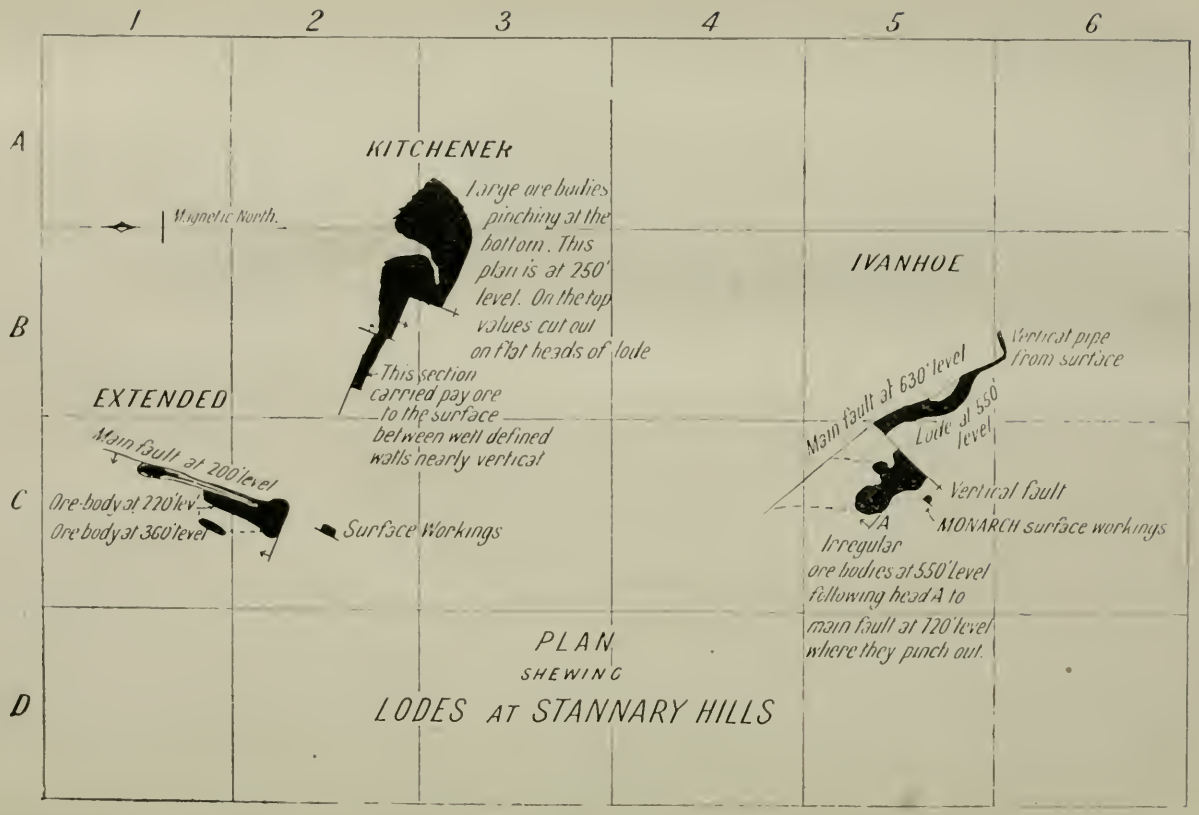
1
2
3
4
5
6
A
B
C
D
KITCHENER
Large ore bodies pinching at the bottom. This plan is at 250' level. On the top values cut out on flat heads of lode
Magnetic North.
This section carried pay ore to the surface between well defined walls nearly vertical
EXTENDED
Main fault at 200' level
Ore body at 270' lev.
Ore body at 360' level
Surface Workings
IVANHOE
Vertical pipe from surface
Main fault at 630' level
Lode at 550' level
Vertical fault
A
MONARCH surface workings
Irregular ore bodies at 550' level following head A to main fault at 720' level where they pinch out.
PLAN
SHEWING
LODES AT STANNARY HILLS

FIG. 2.

The irregular ore-bodies in the western area comprise the group of lodes from the Black Rock (Fig. 1, B2) to the Ivanhoe (Fig. 1, B2). These lodes are of large size, and produced the bulk of the ore treated at the Rocky Bluffs mill. They are situated on the band of greywackes mentioned previously.

To the N.W. of the Black Rock small lodes exist which are of no value, and which gradually die away towards the north.

One feature of the ore-bodies is that the slickensides are nearly horizontal. The map (Fig. 1) shows that the irregular ore-bodies and other lodes of commercial value are all situated near where the sedimentary rocks are bent. The plan of the lodes (Fig. 2) shows that the lodes were much faulted after the lode-formation. Hence it would seem probable that the original intrusion of the granite did not introduce the mineralizing solutions, but that subsequent disturbances of the granite area (Fig. 1, B3) did so, and that further disturbances produced the later systems of faulting. The disturbances would probably be due to the intrusion of acid eruptives in the granite. To fix this theory more detailed work is necessary.

The section herewith (Fig. 3) shows that pay-ore was extracted to the 100-ft. level in the Central and Extended. The Black Rock contained rich ore at the surface, but the lower workings were unsatisfactory.

The Kitchener and Extended lodes at about 150-ft. level commenced to widen out, and were of large size from that level down to the 300-ft. level. Thence to 350-ft. level they become lower in value and smaller in size.

The Monarch, Ivanhoe, and Eclipse had rich surface outcrops above the 300-ft. level. The Ivanhoe and Monarch unite just below the 500-ft. level and form a large body, which petered out at the 700-ft. level.

It seems as if the original lode-channels had somewhat of the nature of a fissure lode, as the enlargements occur where there is a bend in the heads on which the lode is formed. Generally speaking, the lodes are small and rich when vertical, and enlarge when the bends become flatter. Below the bend the lode pinches

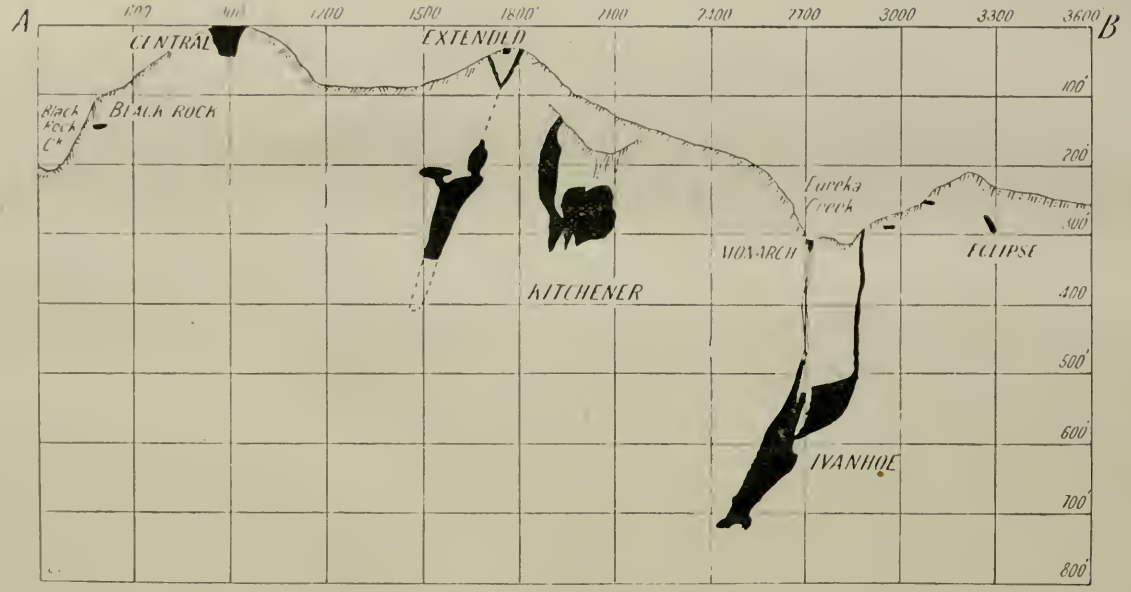

Fig. 3.

Section A B on Map of Stannary Hills showing Ore-Bodies.

out (see Fig. 4). It seems probable that the lodes will occur in depth, as it is unlikely that the heads would follow down without bending. The evidence of the lodes as opened up and shown on the section bear this out. The Ivanhoe, Kitchener, and Extended lodes are the only developed ones, and in each case they have several things in common. Firstly, the above remarks *re* the relation of lode to the vertical dip of the heads apply. Secondly, the larger bodies join up with two more or less vertical pipes of ore and become poor, and split up at the bottom. Thirdly, each body is associated with what may be termed a main fault, which is a vug with pyrites and traces of cassiterite, and is a product of later faulting. This vug enlarges near the lode and dies away as it leaves the ore-bodies. The Ivanhoe is different from the Kitchener and Extended in so far as it occurs in the coarse greywacke and the latter lodes in the fine. Also, the Ivanhoe lode-material consisted mostly of quartz and sulphides of iron, arsenic, and zinc, with little chlorite, and the Kitchener and Extended lode consists of a dark green chlorite with the sulphides of iron, zinc, and arsenic present in a minor proportion, together with magnetite and sometimes galena. The chloritic lodes, where small, are confined between walls, but when they enlarge one wall persists, from which the chlorite lode gradually merges into the country-rock.

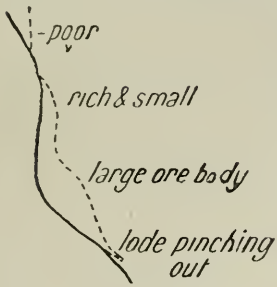

FIG. 4.
SECTION.

In the Ivanhoe the lode-material is enclosed between walls when small, and when it enlarges it does so from two faults more or less at right-angles to each other, as per sketch (Fig. 5). The lode near the faults is mostly filling-material, and as the lode leaves the fault-line it becomes more or less angular blocks of altered country-rock, with the crevices filled in with pyrites, cassiterite, quartz, &c.

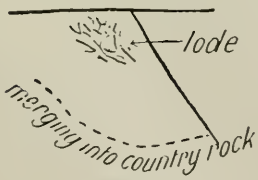

FIG. 5.
PLAN.

Further away the altered country-rock becomes unaltered rock, and the lode finally dies away as small seams of pyrites running into the country-rock.

Some of the faces in this portion of the mine resembled a breccia of country-rock with the crevices filled in with lode-material. In some cases the cassiterite coated the country-rock, and was surrounded by other gangue-material. In other sections milky quartz had replaced all the country-rock.

In the Kitchener, ore values were always good where the chlorite had a rich green tint, but where it changed to a dry-looking green it was no good. In some cases this change occurred on a horizontal head, above which the lode only carried traces of cassiterite.

Another point of note was the presence of black chlorite with rich tin oxide in the country-rock near the lodes, especially in the coarse greywacke. These patches occur on what may be termed incipient faults, as they die away both vertically and horizontally, and shows no signs of movement. The lode-material seems to run into the joints in the country-rock.

GENESIS OF ORE.

Microscopic sections, showing cassiterite, always had the cassiterite crystals well developed, and sometimes broken. Microscope sections of the chlorite lode-material had exactly the same structural features as the fine-grained greywacke. In the Ivanhoe the country-rock fragments, when not completely decomposed, consisted of a soft, light-green chlorite. The cassiterite evidently was formed first of all. In the case of the Ivanhoe Mine the sulphide minerals were then deposited, and finally quartz, the light-green chlorite being due to the decomposition of the country-rock.

In the chlorite group cassiterite and magnetite were deposited in the crevices in the country-rock, first probably as stockwerks, where the lode was large. Then came the sulphides, and finally the chloritizing solutions altered the whole of the gangue.

Lode tin mining is notoriously very precarious, and the writer hopes the foregoing will help those working similar lode-formations. A conception of the facts herein stated, at the outset, would have saved the company many disappointments.

Mr. Herman, in his paper on Australian Tin Lodes and Tin Mills, called for discussion on the accuracy of the vanning assay and its relation to mill extraction. The writer does not intend to discuss this question at length, but would like to say that at Stannary Hills the extractions agreed very closely with the assay results obtained by using the vanning shovel. Mine faces, ore trucks, battery pulps, and tailings were systematically sampled. It was standard practice to first free the sample from excess of sulphides, and especially oxides of iron, by boiling in acids before vanning. The values fluctuated from .20 % to 4.0 % on the average. Tailings had to be vanned at least twice, and where samples carried over 5 or 6 % SnO_2 it was always necessary to van the sample twice, or oftener, to obtain any degree of accuracy.

In conclusion, the writer wishes to thank Professor Skeats for his assistance in the preparation of this paper. As the Stannary Hills mines are now working, a criticism from the present management on the foregoing observations would be of interest.

DISCUSSION.

Mr. H. Herman said there were references to himself in the paper—one in connection with the assay of tin ores. In 1914 in a paper on "Australian Tin Lodes and Tin Mills" he tried by devious means to draw the tin men of Australia on the question of tin assays. He wished to get reciprocity of opinion from some of the men of the West Coast of Tasmania. The question of milling assays as against chemical assays was a very important one in the milling of ores; and he thought it was a very desirable thing that particularly those dealing with the different ores of the West Coast of Tasmania should contribute to the discussion.

FLOW OF COMPRESSED AIR IN PIPES.

BY JOHAN SARVAAS.

COMPRESSED air is held in high esteem by the mining engineer as a medium for the transmission of power. The transmission, however, is accompanied by a high percentage of loss. Of the total work done by the steam cylinder in compressing the air in the air cylinder, less than 50 % is ultimately utilized by the machines underground. These losses are due to its essential and inherent properties as a gas.

One of the sources of loss is that due to transmission through the pipes which distribute the air from the receiver to the various places where it is used.

As the capacity and economic design of air-compressing plant are influenced by this source of loss, it may be of interest to give an outline of how estimates may readily be made in practice of the diameter of pipes, quantity of air discharged, and the drop in pressure occasioned.

In hydraulics we have a general formula given in Rankine's "Civil Engineering":—

$$v = c \sqrt{\frac{d \times h}{l}}$$

Where v is the velocity in ft. per sec.

d is the diam. of the pipe in feet.

h is the available head in feet.

l the length of the pipe in feet.

c a constant coefficient, the value of which, according to Rankine, is 50.

It was suggested, the writer believes, in the first instance by D'Arcy, that this formula could be made to apply to an elastic

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fluid such as air, by the insertion of a term denoting the density of the fluid. D'Arcy devoted a considerable amount of his time to research and experiment in this direction, with the object of fixing values for the coefficient c. In hydraulics c is constant, but D'Arcy found that its value changed with different diameters of pipes in the case of elastic fluids.

For elastic fluids the formula takes the form—

$$v = c \sqrt{\frac{d\ (p_1 - p_2)}{w_1 \times l}} \qquad (1)$$

Where p_1 is the initial gauge-pressure in lb. sq. in.

p_2 ,, final ,, ,, ,, ,,

w_1 is the density or weight in lb. per cub. ft. of the fluid at the initial pressure p_1.

It will be recognized that a pressure-intensity divided by weight in lb. per cub. ft. gives equivalent motive column of the same nature as h in the hydraulic formula.

If Q is the discharge in cub. ft. per min. and d is the diameter of the pipe in inches,

$$Q = \frac{.7854 d^2 v \times 12 \times 60}{1728} = .32725 v d^2 \qquad (2)$$

If we substitute equation (2) (value for v) in (1) we establish the formula in the following form :—

$$Q = c \sqrt{\frac{d^5\ (p_1 - p_2)}{w_1 \times l}} \qquad (3)$$

To simplify practical applications of this formula it may be written—

$$Q = \frac{c \sqrt{d^5}}{\sqrt{l}} \Big/ \sqrt{\frac{p_1 - p_2}{w_1}} \qquad (4)$$

Where Q = discharge in cub. ft. per min.

d = diam. of pipe in in.

l = length of pipe in ft.

p_1 = initial pressure in lb. per sq. in. gauge.

p_2 = final ,, ,, ,, ,,

w_1 = weight of cub. ft. of air at pressure p_1.

For the coefficient c we must accept the determinations of D'Arcy as given in Table I. below, and for still greater convenience values are also given for $c\sqrt{d^5}$ for diameters ranging from 1 in. to 16 in.

Taking the weight of a cub. ft. at atmospheric pressure to average .0761 (although it varies with the temperature), the densities for other gauge-pressures may be obtained with sufficient accuracy for practical purposes as follows :—

$w_1 = .0761\left\{\frac{p_1 + 14.7}{14.7}\right\}$, p_1 being the gauge-pressure for which we require the value of w_1.

Obviously, this formula may be written $w_1 = .0761\ (.068p_1 + 1)$, and a table of values for w_1 and $\sqrt{w_1}$ compiled, as in Table II.

When, as is generally the case, we require to know the equivalent volume of free air corresponding to the volume of compressed air at the terminal pressure, as related to the density of the atmosphere, the following formula may be used—

$$F = q \times w_2.$$

Where F is the equivalent free air in ft. per min.

$w_2 = .068p_2 + 1$ where p_2 is the final pressure (gauge) in lb. per sq. in. of the discharged air.

q = discharge of compressed air in cub. ft. per min.

Again, to facilitate calculations in practical applications, Table III. has been compiled with the help of this formula.

We may next proceed to illustrate the application of the formula and the tables by a few numerical examples.

Example 1.—

How many cub. ft. of compressed air will be discharged from a 4-in. pipe 3600 ft. long, the initial gauge-pressure being 80 lb. per sq. in. and the loss of pressure not to exceed 10 lb. per sq. in ? What will be the volume of the equivalent free air ?

From Table I. $c\sqrt{d^5} = 1856$, and from Table II. $\sqrt{w_1} = .700$.

$$\sqrt{\frac{p_1 - p_2}{w_1}} = \frac{\sqrt{10}}{.700} = \frac{3.162}{.7} = 4.517.$$

$$\sqrt{l} = 60.$$

Hence $q = \dfrac{1856 \times 4.517}{60} = 139.7$ cub. ft. per min. compressed air at 70 lb. per sq. in. final pressure ; and by Table III., $f = 139.7 \times 5.76 = 804.6$ cub. ft. equivalent free air per min. to be provided by the compressor.

Example 2.—

It is required to transmit through a pipe 10,000 ft. long the equivalent of 800 cub. ft. of free air per min., the initial pressure being 90 lb. per sq. in. and the loss of pressure not to exceed 5 lb. per sq. in. What must be the diam. of the pipe ?

$p_2 = 85$ lb. sq. in. $\therefore\ w_2 = 6.78$ (Table III.)

hence $q = \dfrac{800}{6.78} = 118$ cub. ft. of compressed air at 85 lb. per sq. in. gauge.

$\sqrt{w_1} = .736$ from Table II.

$$\sqrt{\frac{p_1 - p_2}{w}} = \frac{\sqrt{5}}{.736} = \frac{2.236}{.736} = 3.038.$$

$$\sqrt{c}\sqrt{d^5} = q \times \sqrt{l} \div \sqrt{\frac{p_1 - p_2}{w_1}}$$

$$= \frac{118 \times 100}{3.038} = 3887.$$

And from an inspection of Table I. we get for the diam. of the pipe a value somewhere between 5 in. and 6 in.

Example 3.—

It is desired to lay a pipe 2 in. diam. 3600 ft. long, which will discharge 30 cub. ft. of air at 80 lb. per sq. in. gauge. What will be the loss of pressure, also what must be the initial pressure ?

$q = 30$, $d = 2$ in., $c\sqrt{d^5} = 297$ from Table I.

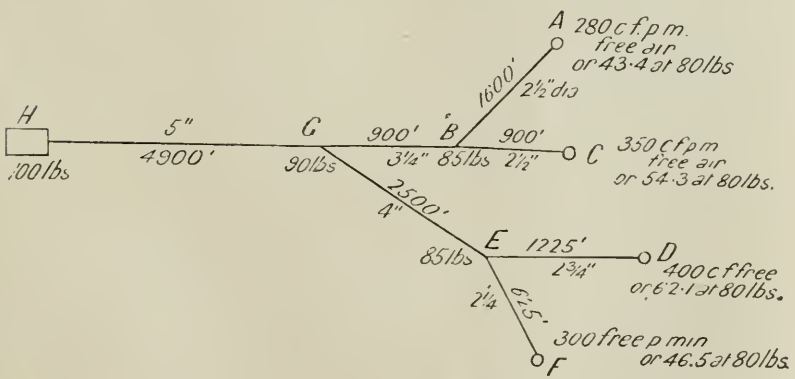
$p_2 = 80$, $\sqrt{l} = 60$, whence we must find $p_1 - p_2$.

$$\sqrt{\frac{p_1 - p_2}{w_1}} = \frac{q \times \sqrt{l}}{c\sqrt{d^5}} = \frac{30 \times 60}{297} = 6.06.$$

$$\therefore \frac{p_1 - 80}{.0761\ (.068\ p_1 + 1)} = 36.72.$$

Solving for p_1 we find its value to be 102 lb. per sq. in. approximately. The arrangement would therefore entail a loss of pressure of 22 lb. per sq. in. and require an initial pressure of 102 lb. per sq. in.

Again, computations can be still further facilitated and arithmetical work reduced to a minimum by using the very useful Table IV. herewith appended. This table was compiled by Mr. Wm. Cox for the Ingersoll-Sargeant Drill Co., of New York, for terminal pressures from 20 to 100 lb. The writer has given in Table IV. a copy of Mr. Cox's table for terminal pressures from 60 to 100 lb. The table gives values for $\sqrt{\frac{p_1 - p_2}{w_1}}$ for terminal pressures from 60 to 100 lb. and for pressure losses from 1 to 10 lb. To illustrate the great practical value of the tables let us assume that an engineer is faced with the following problem :—



H is a large receiver at a generating station. Air is required to be delivered to receivers at stations A, C, D, and F at a terminal

pressure of 80 lb. per sq. in. Distances are given in ft. outlining the whole scheme of reticulation. The number of cub. ft. of free air to be delivered at A, C, D, and F are 280, 350, 400, and 300 cub. ft. per min. respectively. It is required to fix the sizes of the pipes so that the initial pressure at H may not exceed 100 lb. per sq. in.

We begin by converting the volumes of free air required into equivalent volumes at 80 lb. terminal pressure by referring to Table III.

Thus, $\frac{280}{6.44} = 43.4$ cub. ft. per min. at 80 lb. at A.

$\frac{350}{6.44} = 54.3$,, ,, ,, ,, C.

$\frac{400}{6.44} = 62.1$,, ,, ,, ,, D.

$\frac{300}{6.44} = 46.5$,, ,, ,, ,, F.

Now, if we decide to limit the drop of pressure from B to A, B to C to 5 lb., also from E to D and E to F to the same amount of pressure drop, and again a drop from G to B or E of 5 lb., we will have an available drop of 10 lb. from H to G. The pressures at H, G, B, and E may therefore be fixed at 100, 90, 85, and 85 lb. per sq. in. respectively, provided we correctly fix the diameters of the different pipes.

To deliver 43.4 cub. ft. per min. from B at 85 to A at 80 lb. per sq. in., the distance being 1600 ft., we have—

$$q = \frac{c\sqrt{d^5}}{\sqrt{l}} \sqrt{\frac{p_1 - p_2}{w_1}}$$

Using the tables

$$43.4 = \frac{c\sqrt{d^5}}{40} \times 3.115.$$

This gives $c\sqrt{d^5} = 557$.

And from Table I. we therefore conclude that a pipe between 2 in. and 3 in. diam. would suffice—let us say $2\frac{1}{2}$ in. diam.

A similar calculation for the pipe BC would suggest a pipe of $2\frac{1}{2}$-in. also.

Dealing with pipes ED and EF in the same way, we get diameters of $2\frac{3}{4}$ in. and $2\frac{1}{4}$ in. respectively.

There must therefore exist at B a volume of air $= \frac{97.7 \times 80}{85}$ $= 91.8$ cub. ft. per min. at a pressure of 85 lb. per sq. in., and in the same way a volume equal to 102.2 cub. ft. per min. at 85 lb. at E.

At G the pressure is 90 lb., so that we have now to find the necesary diam. of GB.

From the formula and tables we have

$$91.8 = \frac{c\sqrt{d^5}}{30} \times 3.037.$$

$$\therefore c\sqrt{d^5} = 906.$$

Which value from Table I. would suggest a pipe a little more than 3 in. diam.—say, $3\frac{1}{4}$ in. diam.

Similarly, for pipe GE a pipe somewhere about 4 in. diam. should suffice.

We would require at G a flow of air equal to $\frac{(91.8 + 102.2)\ 85}{90}$ $= 184.3$ cub. ft. per min. at 90 lb. per sq. in. pressure.

Finally, we have for the main trunk supply pipe HG,

$$184.3 = \frac{c\sqrt{d^5}}{70} \times 4.101.$$

Hence $c\sqrt{d^5} = 3145$, which would suggest a pipe 5 in. diam. for HG.

The air supply from the receiver at H would be $\frac{184.3 \times 90}{100}$ $= 165.87$ cub. ft. per min. at 100 lb. per sq. in.

Which would involve the compression by the air compressor and delivery into the receiver at H of $165.87 \times 7.80 = 1294$ cub. ft. of free air per min.

The newly-constituted Bendigo Amalgamated Goldfields Co. N.L., recently decided to concentrate its air-compressing plant at three stations, and from these to reticulate the air by pipes to receivers at the various shafts in use. The object was, of course, to enable the company to discard a considerable number of obsolete compressors which it has been compelled to run at an

extravagant cost. The three stations are located at the Koch's Pioneer, Virginia, and Johnson's No. 2 mines. These stations are well on their way to completion, and are intended to provide for from 150 to 180 rock-drills.

The plant at Koch's Pioneer has been designed to supply compressed air to about thirteen mines south from the Windmill Hill shaft, on the Garden Gully line, and also the mines on the Sheepshead line. There are four cross-compound condensing two-stage air compressors, with a total capacity of 4750 cub. ft. free air per min. Steam is supplied from six boilers, arranged in pairs, and working at a steam pressure of 120 lb. per sq. in. Compressed air at 105 lb. per sq. in. is delivered from the compressors to two receivers, and from these receivers pipes convey the air to the receivers at the several shafts. From the Koch's Pioneer station there will be five lines of pipes radiating from the central station, aggregating about two and three-quarter miles of 4-in. and one mile of 3-in. pipes.

The writer trusts that the consideration of the foregoing information, compiled from various sources, may prove interesting to mining engineers called upon to deal with similar schemes for the reticulation of compressed air.

TABLE I.

Diameter. in.	Coefficient. c	$c\sqrt{d^5}$
1	45.3	45.3
2	52.7	297
3	56.1	876
4	57.8	1,856
5	58.4	3,298
6	59.5	5,273
7	60.1	7,817
8	60.7	10,988
9	61.2	14,872
10	61.8	19,480
12	62.1	30,926
14	62.3	45,690
16	62.6	64,102

TABLE II.

Gauge Pressure. lb. sq. in.	w_1	$\sqrt{w_1}$
0	.0761	.276
5	.1020	.319
10	.1278	.358
15	.1537	.392
20	.1796	.424
25	.2055	.463
30	.2313	.481
35	.2572	.507
40	.2831	.532
45	.3090	.556
50	.3348	.578
55	.3607	.600
60	.3866	.622
65	.4125	.642
70	.4383	.622
75	.4642	.681
80	.4901	.700
85	.5160	.718
90	.5418	.736
95	.5677	.753
100	.5936	.770

TABLE III.

p_2 lb. sq. in.	w_2	p_2 lb. sq. in.	w_2
0	1.00	55	4.74
5	1.34	60	5.08
10	1.68	65	5.42
15	2.02	70	5.76
20	2.36	75	6.10
25	2.70	80	6.44
30	3.04	85	6.78
35	3.38	90	7.12
40	3.72	95	7.46
45	4.06	100	7.80
50	4.40		

Table IV.

Values of $\sqrt{\frac{p_1 - p_2}{w_1}}$ in D'Arcy's formula.

Final Pressure P_2	Loss of Pressure equals $P^1 - P_2$										Final Pressure P_2
	1 lb.	2 lb.	3 lb.	4 lb.	5 lb.	6 lb.	7 lb.	8 lb.	9 lb.	10 lb.	
lb.											lb.
60	1.597	2.242	2.730	3.132	3.479	3.787	4.066	4.320	4.557	4.775	60
61	1.586	2.228	2.712	3.112	3.458	3.764	4.042	4.294	4.530	4.747	61
62	1.576	2.214	2.695	3.092	3.437	3.742	4.019	4.268	4.503	4.718	62
63	1.566	2.200	2.678	3.074	3.417	3.720	3.995	4.244	4.476	4.693	63
64	1.556	2.186	2.662	3.056	3.397	3.698	3.971	4.220	4.452	4.668	64
65	1.546	2.173	2.647	3.038	3.376	3.676	3.948	4.196	4.428	4.642	65
66	1.537	2.160	2.631	3.020	3.356	3.654	3.926	4.172	4.404	4.617	66
67	1.528	2.147	2.615	3.002	3.337	3.634	3.905	4.150	4.380	4.592	67
68	1.519	2.134	2.600	2.984	3.318	3.615	3.884	4.128	4.356	4.566	68
69	1.510	2.122	2.584	2.968	3.300	3.596	3.863	4.104	4.332	4.541	69
70	1.501	2.100	2.570	2.952	3.283	3.576	3.842	4.082	4.308	4.516	70
71	1.492	2.098	2.556	2.936	3.265	3.556	3.820	4.060	4.284	4.494	71
72	1.484	2.086	2.543	2.920	3.247	3.537	3.799	4.038	4.263	4.471	72
73	1.476	2.075	2.529	2.904	3.229	3.517	3.778	4.018	4.242	4.449	73
74	1.468	2.064	2.515	2.888	3.211	3.498	3.759	3.998	4.221	4.427	74
75	1.460	2.052	2.501	2.872	3.193	3.480	3.741	3.978	4.200	4.405	75
76	1.452	2.041	2.487	2.856	3.177	3.463	3.723	3.958	4.179	4.383	76
77	1.444	2.030	2.473	2.842	3.162	3.446	3.704	3.938	4.158	4.361	77
78	1.436	2.019	2.461	2.828	3.146	3.429	3.686	3.918	4.137	4.339	78
79	1.428	2.009	2.449	2.814	3.130	3.412	3.667	3.898	4.166	4.317	79
80	1.421	1.999	2.437	2.800	3.115	3.395	3.648	3.878	4.095	4.294	80
81	1.414	1.989	2.425	2.786	3.009	3.377	3.630	3.858	3.074	4.272	81
82	1.407	1.979	2.413	2.773	3.084	3.360	3.611	3.840	4.053	4.253	82
83	1.400	1.969	2.401	2.758	3.068	3.343	3.593	3.820	4.035	4.234	83
84	1.393	1.959	2.388	2.744	3.052	3.326	3.575	3.802	4.017	4.215	84
85	1.386	1.949	2.376	2.730	3.037	3.310	3.559	3.786	3.999	4.196	85
86	1.379	1.939	2.364	2.716	3.022	3.294	3.543	3.768	3.981	4.177	86
87	1.372	1.929	2.352	2.702	3.008	3.279	3.527	3.752	3.963	4.158	87
88	1.365	1.920	2.340	2.690	2.994	3.265	3.511	3.734	3.945	4.139	88
89	1.358	1.910	2.330	2.678	2.981	3.250	3.495	3.718	3.927	4.120	89
90	1.351	1.901	2.319	2.666	2.967	3.235	3.479	3.700	3.909	4.101	90
91	1.345	1.893	2.309	2.654	2.954	3.221	3.463	3.684	3.891	4.082	91
92	1.339	1.884	2.298	2.642	2.940	3.206	3.447	3.666	3.873	4.064	92
93	1.333	1.876	2.288	2.630	2.927	3.191	3.432	3.650	3.855	4.048	93
94	1.327	1.867	2.278	2.618	2.914	3.177	3.416	3.634	3.840	4.032	94
95	1.321	1.859	2.267	2.606	2.900	3.162	3.401	3.618	3.825	4.016	95
96	1.315	1.850	2.257	2.594	2.887	3.148	3.387	3.604	3.810	4.000	96
97	1.309	1.842	2.246	2.582	2.873	3.135	3.373	3.590	3.795	3.984	97
98	1.303	1.833	2.236	2.570	2.862	3.123	3.360	3.576	3.780	3.969	98
99	1.297	1.825	2.226	2.560	2.851	3.110	3.347	3.562	3.765	3.953	99
100	1.291	1.817	2.217	2.550	2.840	3.098	3.334	3.548	3.750	3.937	100

THE HUMAN SIDE OF ENGINEERING.

By F. Danvers Power.

This has been a much-neglected branch of engineering. With the majority of industries labour is the chief item of trouble and expense. Anything that will reduce trouble and increase efficiency is well worth considering. It is only of recent years that any attempt has been made on a scientific basis to improve conditions: sporadic attempts having been made from time to time, privately and by law. Some have been successful, others unsuccessful—not necessarily the fault of those who initiated the ideas, though naturally mistakes were made in some cases for want of experience, but those whom it was desired to benefit were not always prepared for the change, and by their distrust hampered schemes instead of assisting them.

Man power is generally more expensive than machinery, though there are exceptions, such as when a small amount of work has to be done in a place where machinery does not exist, and it would not pay to instal any; or where labour is cheap, and skilled workmen are scarce, as in some tropical countries. When machinery is first introduced it generally causes the suspicion that it will deprive men of their work. It may cause men to vary the conditions of their work, and in some individual cases, when men are unable to conform to changed circumstances, it may result in a certain amount of hardship; but, after all, the less competent must not hold back progress for the general good. Besides, changes, as a rule, do not take place suddenly, so old hands can generally find work at their particular calling till nature requires them to retire. In cases where men take to machinery, they not only find that they are relieved of the

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hardest part of their work, but that they can make better wages. It is true that a machine drill will do the work of several men, but on that account one is enabled to work low-grade ore at a profit that could not be contemplated if hand drilling only was available, thus finding work for more labour (as there is a larger quantity of low than high-grade ore), relieving labour of some of its hardest work, and increasing the available mineral wealth of the country.

A careful manager will look after his machinery and see that it is kept in good condition; why should he not take similar care of those working under him? In the United States a new profession has sprung up. The "social secretary" not only improves the conditions of life and labour for the individual in the mine or factory, but also in his house. It is now recognized that regard for the worker is a large factor in securing contentment and industrial peace. Too often opposing parties will study one side of a question only, whereas due consideration should be given to the thoughts and feelings of the other side Besides the physical welfare of a man, we must consider him more or less of a thinker. His ideas may be right or wrong from our outlook, but in order to properly understand him we must try to look at matters from his point of view. It is not a question of

"O wad some power the giftie gie us
To see oursels as others see us!"

but give us the power to see matters from the other man's point of view in order that a fair comparison can be made and due weight given to his opinions. By knowing how others are likely to look at things, steps may often be taken to make alterations and avoid trouble. If everyone played the game, work would go on with but little trouble, but, so long as human nature is what it is, and selfishness reigns supreme with both rich and poor, and while one tries to take advantage of the other, physically or mentally, then there will be trouble. As the human race is composed of individuals in various stages of evolution, their ideas vary considerably, and frequently clash. We not only have to deal with

those who, agreeing on some point or points, combine together to make a powerful force, but also those who are in the minority.

Every country has its own problems. The United States of America has to deal with white and coloured labour. On account of its proximity to Europe, the poorer class of white people from various nations find their way to the United States. This brings in the language difficulty, and certain national prejudices have to be overcome. Although in Australia we may have representatives of as many nationalities as there are in the United States, they form but a small proportion of our population, and have perforce to learn the language of their adopted country.

Conditions of work to-day are different to what they have been in the past, and this necessitates an alteration in our mode of living. Much unrest is due to the fact that these variations have not fitted in with one another. At one time members of a family would carry on a trade and live under the same roof, and later on when a master employed but two or three men, they often lived together, and master and man were in constant personal touch; but to-day this personal contact is lost, the employer in many cases not knowing those working for him even by sight, in fact he frequently works in another part of the establishment, or even in another part of a town or country, and attends to the commercial part of the business, leaving a manager to look after the works. The human part of his business is generally left to look after itself, and not infrequently falls into the hands of some professional agitator.

Our existing customs have developed through expediency. Some have served their purpose and are being cast aside to give place to others more suited to present circumstances. What was quite right and proper under one set of circumstances may be entirely wrong under other conditions, but that is no reason why we should confound past customs with present conditions, and then jump to the conclusion that we are oppressed. In many cases, were the old customs we now denounce non-existent, the people could scarcely have lived. Now we have to deal with

larger populations; means of transport by land and sea are rapid; we can get raw material from any part of the world; we can speedily communicate from one part of the world to another by means of electricity; we have pressed certain motor forces to the service of man; and in many other ways live under entirely different conditions.

The day of the private individual is fast giving place to that of companies, so far as the employment of labour is concerned. People of small means can invest their savings in large concerns. Even Governments, not content with taking over public utilities, such as railways, tramways, post and telegraph, etc., have entered into competition with private individuals by establishing brick-works, cement works, bakeries, butcheries, fisheries, etc., and, although having everything in their favour and the purse of the country behind them, they have not, on the whole, been a success; nevertheless, they will doubtless persist, and at some future date get more, if not all, the necessary industries into their hands. Even then there must still be managers, and the man who rises to that position will be the same sort of man who fills the position in private enterprises at the present day.

A man's welfare depends chiefly on—

(1) The laws of the country in which he lives.
(2) His employers and those placed over him.
(3) Himself.

In Australia legislation has done much to improve the conditions of the working man. The law limits his working hours; he has to be paid a living wage; he has to be compensated for accidents he meets with while employed by others; and certain sanitary laws have to be complied with in connection with his dwelling. As far as miners are concerned, there are regulations as to ventilation, the laying of dust, the storing and handling of explosives, precautions against fire and gas explosions, escape-ways and refuge places, danger signs and fences, uniform code of signals for hoisting, inspection of boilers hoisting machinery and ropes, wash and change houses, filing of surveys of old workings, etc.

One of the chief elements in successful management is the ability to deal intelligently with men. One should first endeavour to understand that complex subject, human nature. It is no use saying all men are equal—they are not; and everyone who stops a minute to think knows that such a statement is untrue. We are not equal from the day of our birth, or even before it. We are neither mentally nor physically equal. When the necessity arises, the man with the best combination of qualities will forge ahead of the others, whether he be rich or poor. This has been demonstrated time and again among soldiers, doctors, engineers, etc. Individuals, and even nations, are not all at the same stage of evolution. Many are still in the early stages, and must be cared for because they are unfit to look after themselves. We recognize that a boy in the ordinary course of events will become a man, and when he is a man he will have rights unsuited to an inexperienced child; but in the meanwhile it would be bad for the development of the boy were he treated as a man, for neither his tastes nor abilities would be mature. We must deal with primitive natures in a similar spirit. From the way that the majority of the public allow themselves to be led instead of thinking for themselves it looks as if in a sub-conscious way they recognize their own limits and want of a leader. With such people one must act cautiously. The individual mind moves quickly, but the mind of the mass moves slowly. Established customs cannot be suddenly changed without a violent upheaval, and this generally results in a period of chaos, during which much of value is lost for ever. This has been demonstrated over and over again in history, and again quite recently in Russia. Evolution is gradual development; a revolution is the milestone that marks an important stage in evolution. This may be effected quietly, as when steam and electricity were pressed into man's service, or may be violent, as when accompanied by anarchy, when there is much unnecessary waste of life and property.

It would seem as if some primitive characters must have a periodical diversion of some sort, like the aboriginals who take

"a walk about bush" when they feel the necessity to go wild for a time. Such periods are more common in the early, irresponsible years of a man's life. Such men often act as some agitator suggests without thinking for themselves, or even caring how their actions affect others, even their mates. Then some men are always living in the past, and brood over supposed wrongs that happened to unknown people in bygone days, while others live in the future, and try to apply Utopian ideas to the present day. Some people are always dissatisfied, probably because they have not yet found their own niche in the world. One cannot but sympathize with those who find themselves in uncongenial surroundings, for it is difficult to be fully efficient if not content.

The expression "efficiency" is unpopular in certain quarters, because it has been abused by old-time bosses whose idea of efficiency was to drive men to work harder to increase production rather than to do things methodically, and make the best use of materials at their command. A manager should be a shepherd, not a snarling watch-dog. The engagement of men is best done at some central place, and not left haphazard to the shift boss to hire and fire as he thinks fit, as this gives him the opportunity, often availed of, to vent his spite on a man he does not like, and to give work to personal friends and relations who are not always suitable. Another advantage of engaging men at a centre is that there is no fear of a man discharged from one part of the mine or works for a good reason being re-engaged. When labour is scarce, one has to accept what offers; but when there is a choice, in order to be efficient, the men should be selected and placed according to their ability and strength. The qualities that go to form a man's character and body are so varied that no two men are found alike, but some may be sufficiently alike in temperament and physique to be placed in one class. Because a man is a failure at one sort of work for which nature did not intend him, it does not follow he may not be a success at another kind of work more suited to his abilities. It is not only better for the employer to change the nature of such a man's work, but

it is a kindness to the man himself, for, being more interested in the new work, he feels he can carry out satisfactorily to himself and his employer, he is more likely to be contented, do better work, earn higher wages, and not be a drag on his mates. As matters stand at present, if a man is unsuited for one class of work he is discharged, whereas if he were transferred to another department he might prove of great value.

A man may often be encouraged to take a greater interest in his work if he knows he has a chance of promotion ; but promotion must be done with judgment, for many a good workman has been spoilt through making him a boss, owing to his lack of the necessary qualities to control men. Another way to encourage men in their work is to have a suggestion box, and pay for any suggestions of value that are adopted. The principle is right, but the practice has often proved a failure because the details have not been properly carried out.

The remuneration of workers requires careful consideration. Individual merit is the proper system, but it is not easy to make it uniform or easily understood by the men ; for these reasons it is often thought better to have average efficiency as a basis, and pay those employed at the same class of work the same rate of wage, whether they do equal work or not. It is only fair that the more skilled and steady workman should receive some advantage over the incompetent and shifty individual. In some industries they participate in the profits of the concern, but mining, as a rule, does not lend itself to that. Letting contracts at a price that will allow a capable man to make more than wages without over-exerting himself, or some form of bonus, is more suited to the mining industry. When once a contract price has been established for a given class of work, it is not so much the business of the manager how much a man earns as how much the work costs, and he should not discourage a quick worker by cutting down his rate of pay. If a man stays long in one position he saves his employer the cost of hiring and breaking in a new man, efficiency is increased, there is less liability to accidents, and, if he holds interests in the neighbourhood, he is less likely

to go out on strike for some paltry reason. His employer can therefore afford to pay him an annual bonus for tenure of service. The miner, for his part, gets a definite financial reward, does not lose time and money by looking for work, and saves the expense of shifting from place to place.

A dishonest man, when he meets with an accident, may magnify his injury or pretend he has not recovered when he is well again. While on the sick list he is having an easy time, and receives pay, possibly from some friendly society, as well as from the company. The local doctor, being largely dependent on the working class for his living, gives them every latitude, so that it is sometimes necessary to obtain the advice of an outside medical practitioner to expose the fraud. Such malingering should be nipped in the bud, for, besides reducing the man-power of the mine, and accepting money to which he has no right, his mates soon get to know those who make themselves out to be worse than they are, and if allowed to pass unchallenged the trouble is liable to spread. A man suffering from hysteria, though recovered from the actual accident, is in a different position, for he really believes himself to be worse than he is, and his mental condition makes him suffer as if he were.

Motion and time studies are matters for a special man rather than for the manager, who has his time fully occupied with routine work. Workmen as a rule object to such notes being made, for they believe it is done for the purpose of driving them. This class of work must therefore be undertaken with caution, and with selected men. The real object is, of course, to eliminate unnecessary actions and so arrange things that a man may become more efficient with no extra effort on his part. This puts it in the power of his employer to pay higher wages than he could otherwise do. It is the separation of the essentials from the unessentials. Besides giving an idea of a man's efficiency, and whether he attends punctually, by keeping a record of time under ordinary conditions the manager is enabled to fit in special work without upsetting the ordinary routine. Without tests one has to depend largely on guesswork.

Closely allied to the above subjects is that of fatigue. Fatigue is due to self-poisoning of the blood, which is thereby retarded in its oxidation. If a man is overworked, physically or mentally, the blood takes a long time to right itself, but if working normally the poison does not accumulate, so he does not require such long and frequent spells of rest. The object of fatigue study is to determine the amount of fatigue resulting from various kinds of work, to eliminate all unnecessary fatigue, to reduce the necessary fatigue to the lowest limits, and provide all possible means for overcoming fatigue. Fatigue is a large factor in the rate of work and length of a working day.

To run things smoothly, an establishment must be properly organized so that there is no clashing of departments. The interests of different departments are not always the same. For instance, a mine manager naturally wants to show low costs per ton, so extracts ore in the cheapest manner, which may mean the dilution with wall-rock and contamination with hurtful minerals, which would be cheaper to keep out in the mining than dispose of in the mill or smelter. The metallurgist, on the other hand, cannot show good results if he has to deal with mullock which carries away values, or objectionable minerals that cause constant fluctuations in the process. In such a case it is necessary that someone should co-ordinate these opposing interests for the benefit of the company. The success of a mine largely depends on the shift bosses ; it is they who come in closest touch with the miners, and are in the best position to notice details. Unfortunately, suitable shift bosses are rare ; they are not specially trained, and they never know when they may have to fall back into the ranks again and work among men who on former occasions they have had to call to task. Knowing this liability, they do not always carry out their work conscientiously. If shift bosses were trained for that work, and looked on as a special class, that difficulty would be largely removed. In time of slackness officers should be trained to take the place of the next higher, so that in case of sickness, death, or other cause that obliges a man to leave his employment, temporarily or per-

manently, the work of the establishment can still go on. Every man should clearly understand what is expected of him; who he is working under; and his boss should see that he is supplied with suitable tools and material with the least possible waste of time.

There are many other things that an employer may interest himself in. For instance, he may encourage suitable men to own their own houses by advancing money at a low rate of interest. Men who have something to lose if they leave the district are more settled than those who have not. The establishment of a company co-operative store, which pays the company a fair interest on the outlay but does not exploit the employé, is a good plan in some places where there is not a selection of stores for the men to obtain goods from. In such a store any profits made are divided among the men who use it, the company looking to the mine for dividends. Stores run solely by the mine are not favoured by the men, who are always suspicious that the company is making money out of them. Yet such stores are occasionally necessary in order to prevent the local storekeepers from raising the cost of living, which means the company has to pay a higher rate of wages, the increase going into the pocket of the storekeeper. Interest should be aroused in the community in addition to the job. It may be advisable to establish a club or public hall where entertainments can take place, or set aside a sports ground. The men will not appreciate or take care of the property if everything is done for them by the company, as they are apt to suspect some ulterior object that may work against them. The company might perhaps grant the land and supply the material, while the men give their labour. Healthy amusements will not eliminate the deep-rooted tendency to gamble, but will help to serve as a counter-attraction. Night schools may be established for the benefit of those who wish to improve their position, and members of the staff will generally be found willing to give their assistance. In new districts it may be advisable to establish a boarding-house, for men cannot be expected to do a fair day's work if they are not properly housed and fed. It is, however, generally found

better to get someone else to run the boarding-house than for the company to do so, as in the latter case the men are more satisfied with what they get.

A man may do much to better his position, but not infrequently his progress is retarded by rules of the union to which he belongs, or practices which favour the loafer or incompetent, and bring one who is able and willing to do a fair day's work on a dead level with the inferior man. Such rules are often passed by the undesirable section, who get the initiative because the more steady and experienced men absent themselves from the meetings. Some men prefer to strike for a few pence increase in wages rather than increase their pay by increased efficiency. There is naturally a time in the life of a man when he is more active than later on. It is about that time that he generally wishes to save money to enable him to settle down to family life. If he is able to work better and make more money at that period of his life, why should he not be allowed to do so? Not only does he personally benefit, but also his country. On the whole, individual miners prefer the contract system, as giving them an opportunity to make more than at wages. It is recognized that they are not setting the pace, for it is generally understood that wages men do not work so hard as those on contract.

Some men object to individual capitalists on account of the great power money gives them over those who have little or none, and for that reason they would like to see the State own all industries; but even then the administrative power would be in the hands of a few, and from past experience State-owned industries are no better managed, and are not immune from strikes. Many men object to others being better off than themselves from purely selfish motives, no matter whether he be a so-called capitalist or a mate. They would rather drag them down to their own level than see them prosper, and are incapable of looking ahead and noting where that would lead them. To this class belong the go-slow; they work just enough to produce their wages, and take care that no profit is earned by those who have

made it possible for them to find employment. Actions of this sort have driven much capital out of the country.

The home life of a man is largely his own affair so long as he is not a nuisance to his neighbours. However, if he sells his labour to others he should see that he keeps himself fit. This he cannot do if he gets drunk, eats unsuitable food, or takes insufficient rest. The latter may be due to staying up unnecessarily late, or possibly to sickness in the house. The night shift is generally objected to by miners. The men cannot sleep well during the day, they are disturbed by the usual day noises of children and tradesmen, and in the summer by flies and heat, consequently they are not properly rested. It is notorious that the night shift does not do so much work as the day or afternoon shifts; moreover, they are frequently caught napping. In most collieries, except in their early development stage, the night shift is done away with; but in metal mines the conditions are different. There are not so many faces from which to get ore, and economic conditions generally require that the third shift be worked or the mine closed down.

The living conditions of a man play a large part in his efficiency. Besides nourishing and well-cooked food, he should have home refinements that are restful to his mind as well as to his body. Squalid surroundings do not tend to contentment.

Judging from the general unrest, and allowing for the emotional waves that are sweeping over the world, it is evident that the present state of things is not well suited to the times. The State, employer, and employé each has its own particular function; no one alone can rectify all differences. Both capital and labour are necessary for the production of wealth. If one fails the other is no use; they therefore have certain grounds in common. To abolish individual wealth would do away with one of the main incentives to work, and would penalize those who are industrious and thrifty and wish to make provision for their old age or those dependent on them, so as not to be a burden on the State. Emotions are not confined to any particular class; but those

belonging to one class are more likely to direct their emotions towards certain objects that they come in contact with and understand than another.

"If every man's internal care
Were written on his brow,
How many would our pity share
Who raise our envy now!"

Every opportunity should be taken to explode mistaken ideas and remove misunderstandings and distrust.

The causes of discontent are many, and, when dealing with masses, cannot be varied at a moment's notice, for one industry reacts on others, as has been shown in the cases of the railway, coal, gas, wharf labourers', and other strikes. But when the cause is reasonable it can generally be removed, or at least mitigated. Discarding personal failings which are best dealt with in judicious early training, such as jealousy, undue opinion of self, greed, laziness, injustice, ignorance of economic matters, and want of sympathy, probably the chief troubles are—(1) the desire for a better ratio between the rate of pay and the cost of living; but these are so inter-related that it is difficult to see how it can be brought about unless there is greater efficiency, for if wages go up and the production is not increased in proportion, the cost of an article must also increase, and that cost has to be borne by the consumer or else he has to go without. Efficiency may be increased by the employer if he improves his organization and supervision, and supplies suitable tools. These points have been touched on in the earlier part of this paper, but each is capable of being developed into a special article. The employé may increase his efficiency by saving time and material and keeping his eyes open for improvements. (2) Unsuitable bosses, whose only idea of efficiency is to speed up work and cut down wages. (3) Men put to a class of work for which they are unsuited. (4) Monotony of the work and uncongenial surroundings.

Unfairness on one side generally brings reprisals from the other. Though many men work loyally and take a pride in their work, there are others who will do as little work as they can. The

employer cannot afford to pay men for what they do not carry out, and, although he would gladly pay a good workman more than the minimum wage, so long as the loafer has to be paid more than he is worth the better workman has to suffer. Men know of this loafing; that is why they object to large contract parties, because of the difficulty of obtaining many men of the same ability, and a false idea of loyalty, which is one-sided, not infrequently causes a good miner to throw up a contract and leave the district rather than throw out the loafer. F. W. Taylor sums the matter up as follows:—"The principal object of management should be to secure the maximum prosperity for the employer, coupled with the maximum prosperity for each employé. The maximum prosperity for the employé does not only mean high wages, but the development of each man to his state of maximum efficiency so that he may do the highest grade of work for which his natural abilities fit him, and giving him, when possible, this class of work to do."

Papers and Discussions.

CONTENTS.

PAPERS—

Page

Intensive boring on the Wonthaggi Coal-field (with 3 Plates and 9 Figs.). By H. Herman - - - - - - - - - - 145

A New Phosphate Deposit in the Howqua District, near Mansfield, Victoria (with 1 Plate and 2 Figs.). By Ernest W. Skeats and E. O. Teale - 155

Notes on the Blair Athol (Queensland) Coal-field. By J. F. Hall - - 177

DISCUSSION—

On a New Phosphate Deposit in the Howqua District, near Mansfield, Victoria 165

INTENSIVE BORING ON THE WONTHAGGI COAL-FIELD, VICTORIA.

By H. Herman.

The Wonthaggi coal-field lies south-easterly from Melbourne at a distance by rail of 86 miles, on the flats of the Powlett River, immediately to the south of the deep-cut valleys and steep intervening ridges in the Jurassic rocks of the Bass Range and its foot-hills. The coal-bearing area is covered with a thin layer of late Tertiary and Recent deposits, which serve to mask the true character of the underlying coal-bearing rocks and effectually prevent the appearance of any coal outcrop. Two or three bores sunk prior to 1890 had shown the locality to be really a potential coal-bearing one. Only one additional bore was sunk in the State Coal Mine area until 1908, when energetic boring was resumed, with the result that in November, 1909, when an acute shortage of black coal in Victoria resulted from the prolonged strike on the New South Wales coal-fields, coal-seams had been located at Wonthaggi offering sufficient inducement to start an

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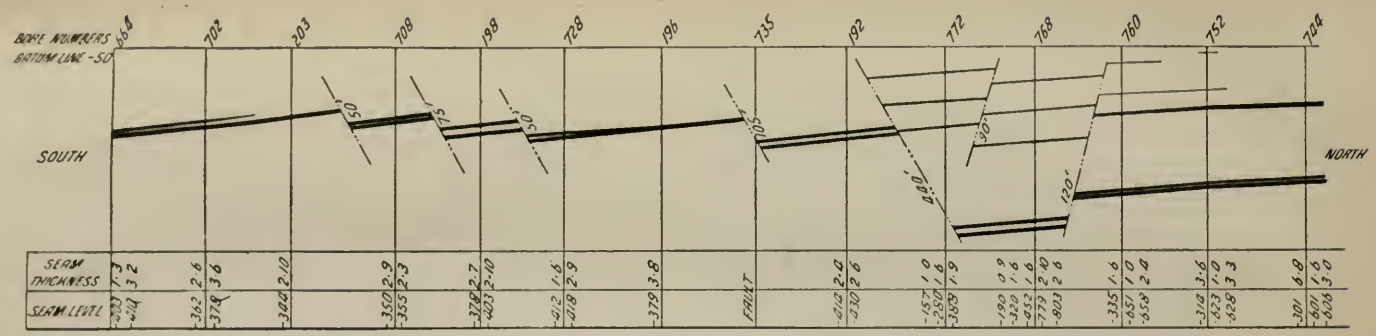


FIG. 1.

SECTION THROUGH WESTERN AREA—A.A. PLATE II.

Scale—1320 ft. Hor.; 800 ft. Vert.; to the inch.

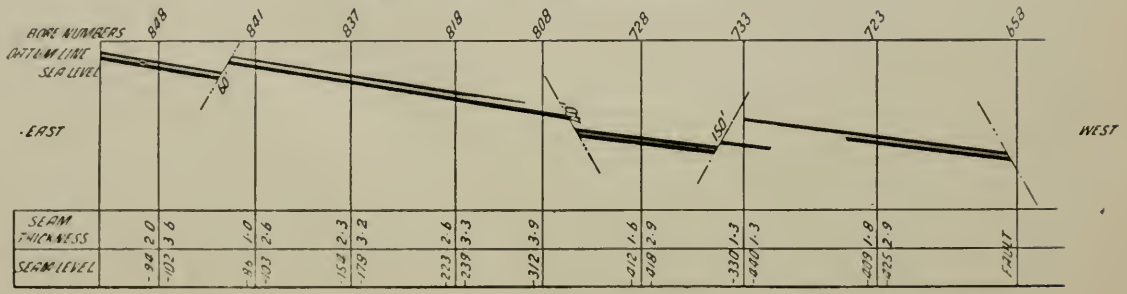


FIG. 2.

SECTION THROUGH WESTERN AREA—B.B. PLATE II.

Scale—1320 ft. Hor.; 800 ft. Vert.; to the inch.

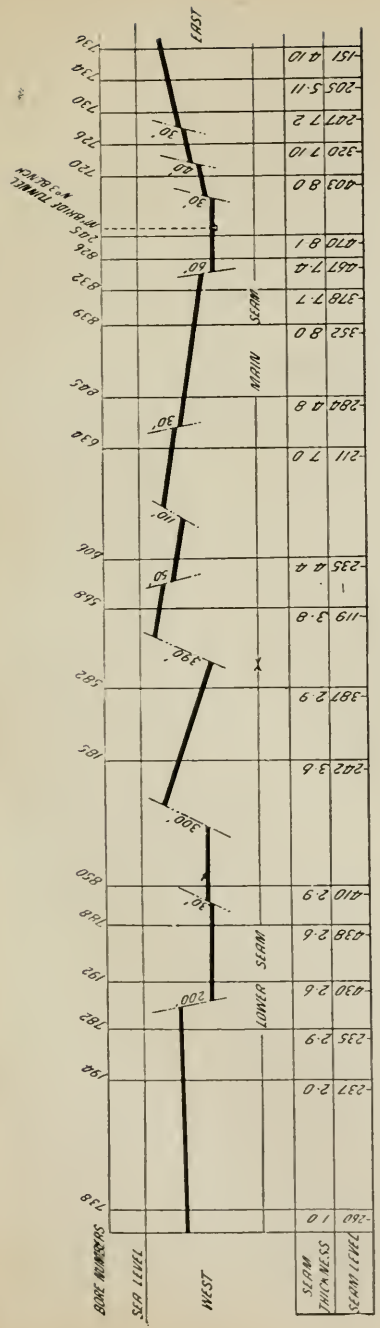


Fig. 3.
Section through M'Bride Tunnel and Western Areas—C.C. Plate II.
Scale—2400 ft. Hor.; 1200 ft. Vert.; to the inch.

emergency mine to relieve the position in Victoria. The coal being within 100 ft. of the surface where first worked, a number of shallow shafts were started, the hauling being done with Victoria core drills and the coal conveyed by bullock waggon to Inverloch, and thence by water to Melbourne. A branch railway was meanwhile being rapidly constructed from Nyora, on the main South Gippsland line, and the emergency mine, in the space of a few months, showed that it was capable of living with its inter-State competitors in times of industrial peace as well as in times of industrial strife.

The total output of coal from the Wonthaggi State mine to the end of 1917 has been 3,490,000 tons. Its present output is about 1500 tons per day. This considerable output is achieved under difficulties that would speedily discourage a colliery manager accustomed to the thick, comparatively untroubled seams of Newcastle and Maitland. Two workable and quite a number of minor seams are known, but the best of these is liable to

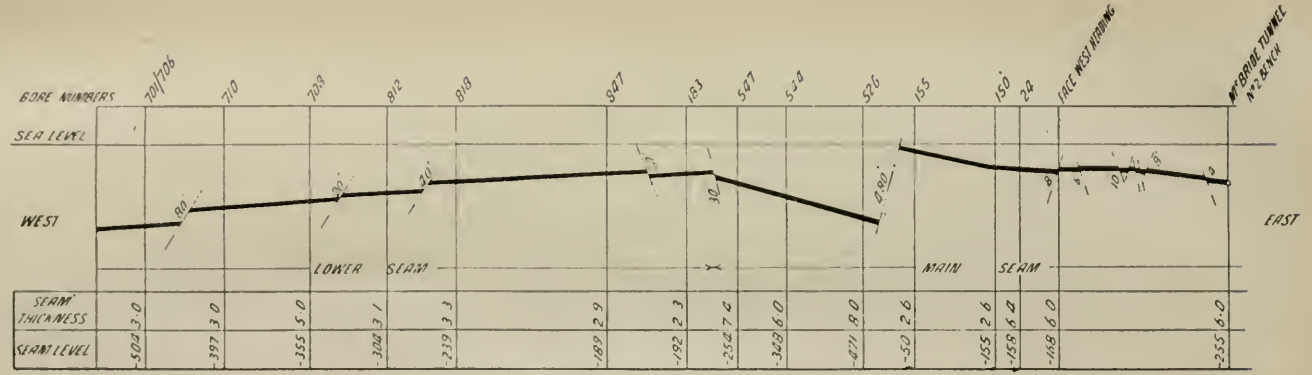


FIG. 4. SECTION THROUGH M'BRIDE TUNNEL AND WESTERN AREAS—D.D. PLATE II. Scale—2400 ft. Hor.; 1200 ft. Vert.; to the inch.

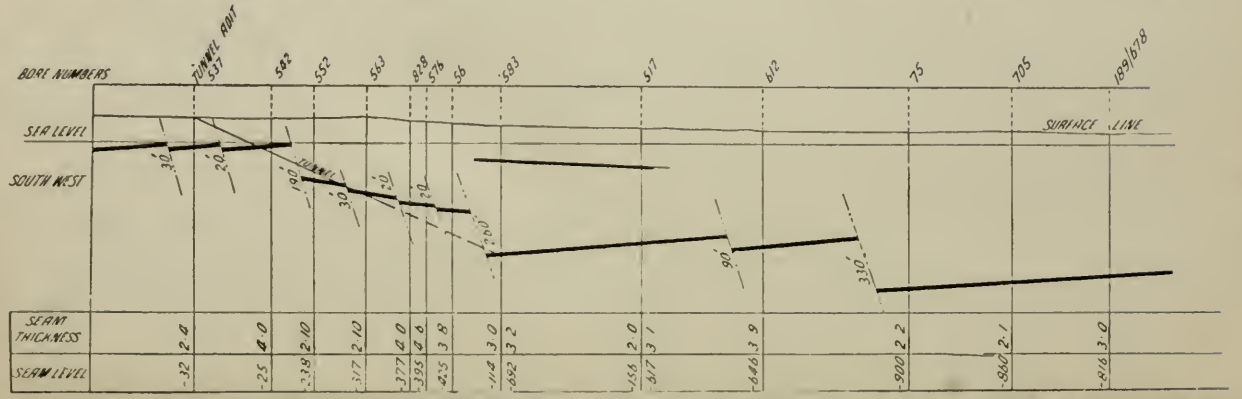


FIG. 5. SECTION ON LINE OF EAST AREA TUNNEL—E.E. PLATE III. Scale—2400 ft. Hor.; 1200 ft. Vert.; to the inch.

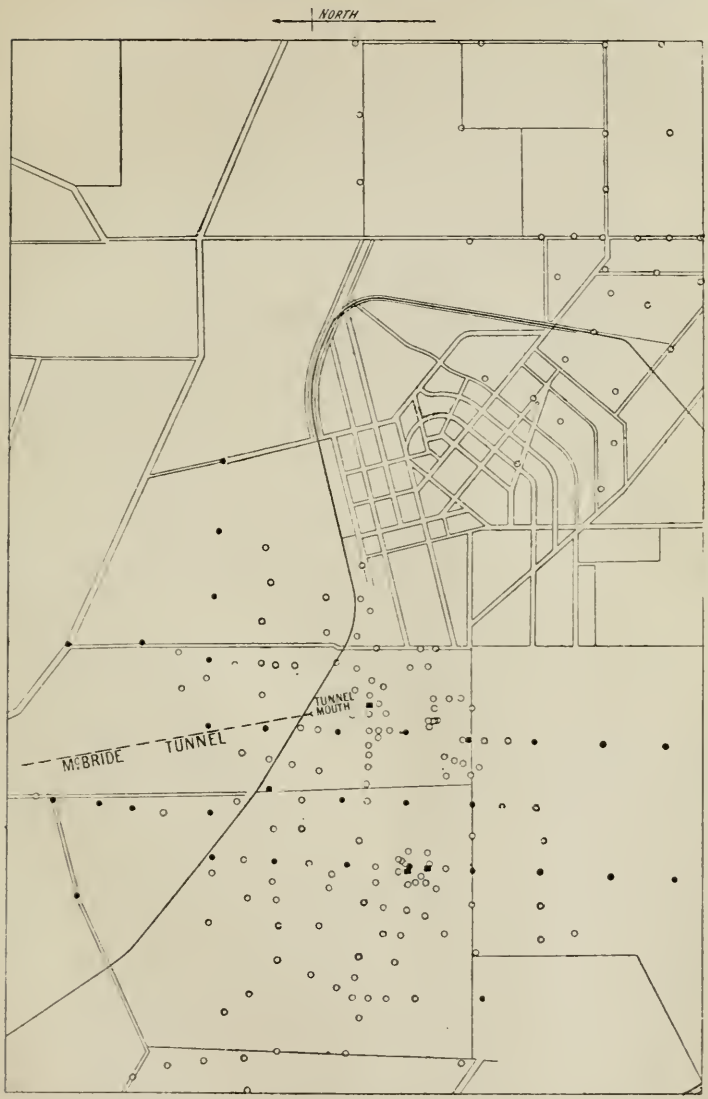


FIG. 6.
SHOWING BORES ON PORTION OF STATE COAL MINE AREA TO END OF 1911.
Scale—60 chains to the inch.
Black circles represent bores to end of 1909. Open circles represent bores during 1910 and 1911.

sudden changes in thickness, quality, and dirt-bands, as well as to "wants," thinning out, and splitting, while all are broken by an exceedingly large number of faults striking and dipping in

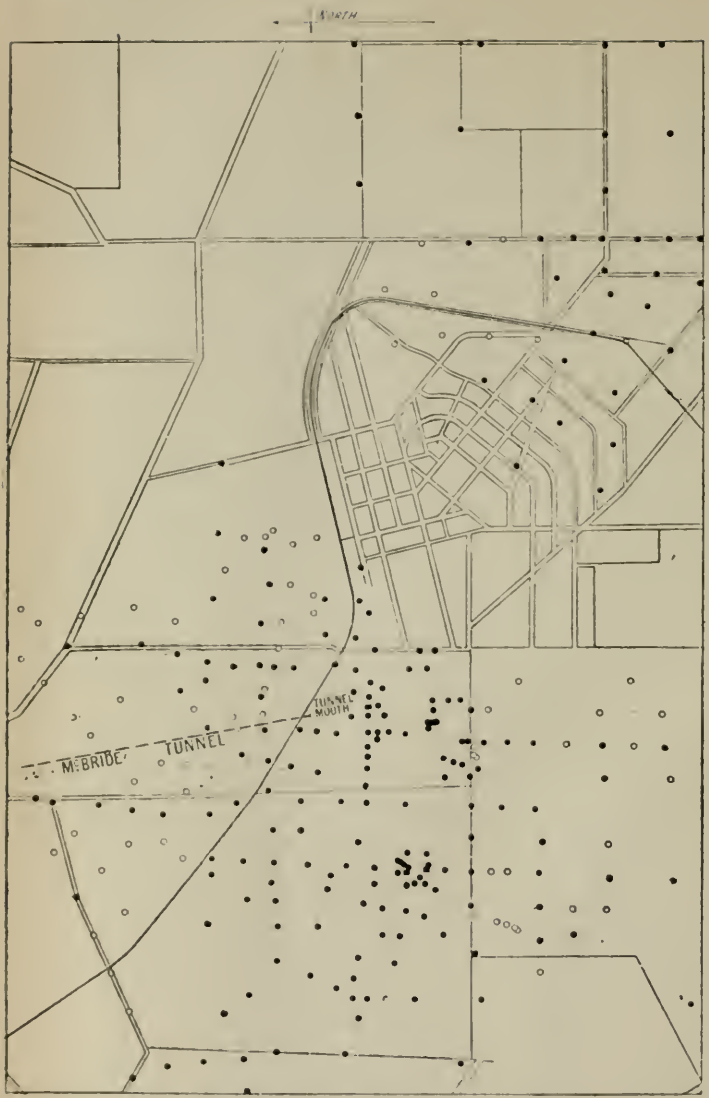


FIG. 7.
SHOWING BORES ON PORTION OF STATE COAL MINE AREA TO END OF 1913.
Scale—60 chains to the inch.
Black circles represent bores to end of 1911. Open circles represent bores during 1912 and 1913.

every conceivable direction, and causing vertical displacements, in places, of several hundred feet. Fortunately, the workable coal over a large portion of the field has been shallow enough to render

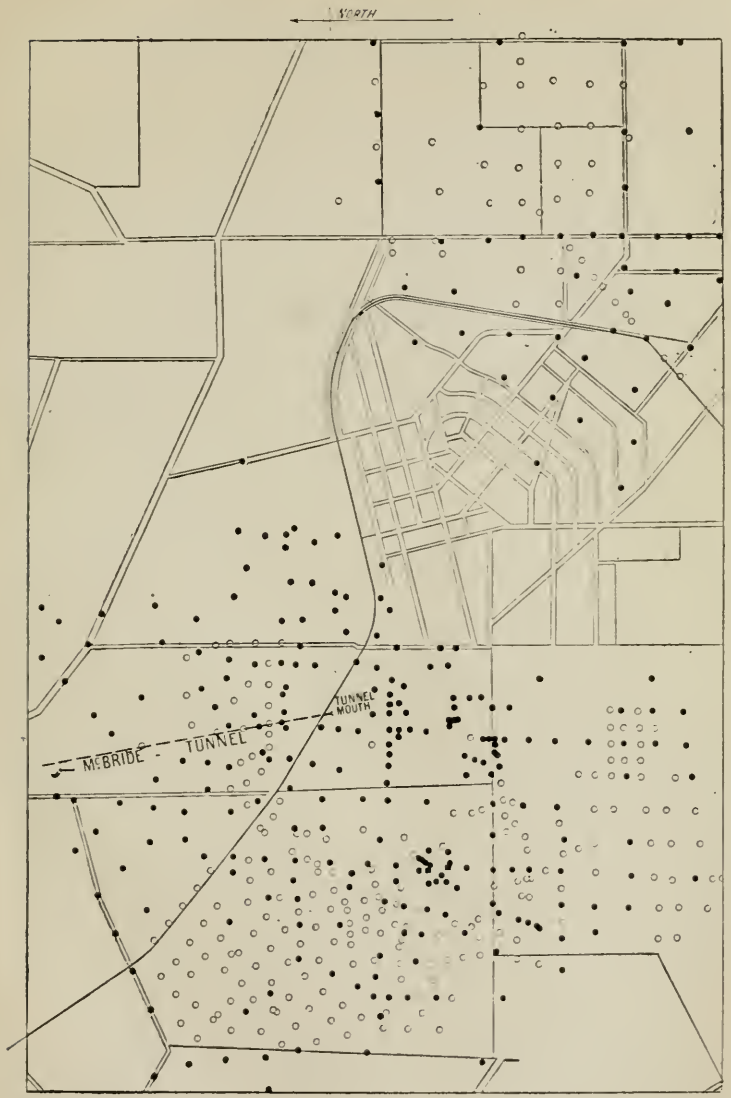


Fig. 8.
Showing Bores on portion of State Coal Mine Area to end of 1915.
Scale—60 chains to the inch.
Black circles reprent bores to end of 1913. Open circles represent bores during 1914 and 1915.

boring economically practicable to locate the various benches of faulted coal, thereby enabling the underground operations to be planned with a degree of certainty otherwise unattainable, and

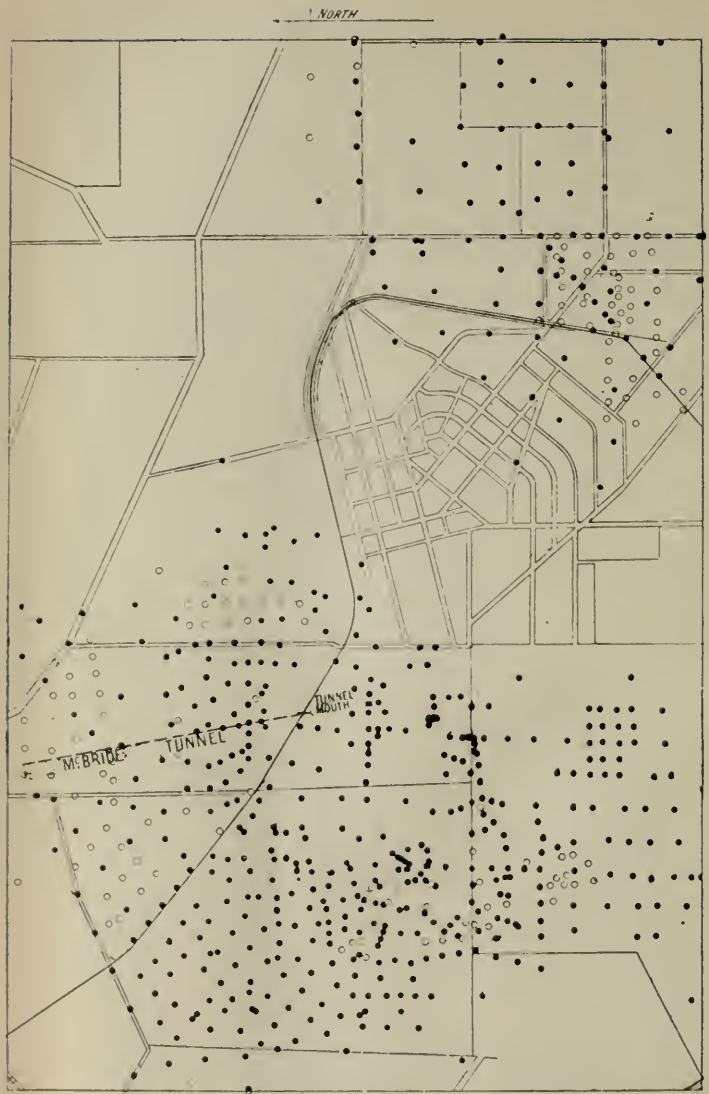


Fig. 9.
Showing Bores on portion of State Coal Mine Area to end of 1917.
Scale—60 chains to the inch.
Black circles represent bores to end of 1915. Open circles represent bores during 1916 and 1917.

costly errors in developmental work to be avoided. Recently, however, the dip of the seams has carried workings into much deeper ground, and bores over 1000 ft. in depth are now not uncommon.

The sections shown in figs. 1 to 5 and Plates I. to III. explain the difficulties of working the Wonthaggi seams much better than could any written description.

The southern portion of Plate I. indicates that in addition to the troubles cited above, that of finding the coal-measures replaced at a shallow depth by Silurian rocks has to be faced.

In the Wonthaggi East area, where a new dip-heading with a full surface equipment is at the present time being established, it has been necessary to sink within an area of about half a square mile no less than 13 bores, varying in depth from 752 ft. to 1254 ft., showing a total footage of exactly 13,000 ft. and an average of 1000 ft. per bore. During the calendar years 1908–13 inclusive the annual footage bored was as follows :—

Year.	Ft.
1908	9,284
1909	7,941
1910	36,243
1911	31,050
1912	22,270
1913	7,511

For the past five financial years (June to June) the boring record for the State Coal Mine alone is as shown in the following table :—

Year.	No. of Bores.	Ft. Bored.	Total Cost. £	s.	d.	Cost per Foot. s.	d.	Cost per ton Coal braced. d.
1913–14	80	16,763	2,274	6	8	2	8.56	1.07
1914–15	119	38,408	4,352	10	3	2	3.19	1.84
1915–16	120	55,204	7,049	7	9	2	6.65	3.73
1916–17	114	56,276	6,769	8	9	2	4.87	4.41
1917–18	137	52,098	7,184	13	2	2	9.09	4.51
		218,749	27,630	6	7	2	6.31	

To illustrate the figures in the above table, figs. 6 to 9 have been prepared. These figures show at a glance the rapidity with which the bores have increased during successive two-yearly periods in the last nine years. Probably no other coal-field in the world has been as intensely bored as the State Coal Mine area

at Wonthaggi. Notwithstanding the low cost per ft. and the large output of coal, it will be seen from the table above that the cost of boring has reached about 4½d. per ton of coal. Four Victoria drills and one steam drill are kept continuously working three shifts, and there is still a large amount of boring to be done.

Full particulars of the drills used, of the mine workings and equipment, and other features of the Wonthaggi field, are contained in the Institute Proceedings for 1914 (N.S., No. 14), in papers by Messrs. Broome, Hunter, Ower, M'Leish, and Robertson.

The author is indebted to Mr. G. H. Broome, general manager of the State Coal Mine, for statistics and sections in figs. 1 to 5 (which were kindly prepared by Mr. Pitt, State Coal Mine surveyor). Plates I. to III. are reprints from the author's report on boring for 1917, in the annual report of the Secretary for Mines, Victoria, for the same year.

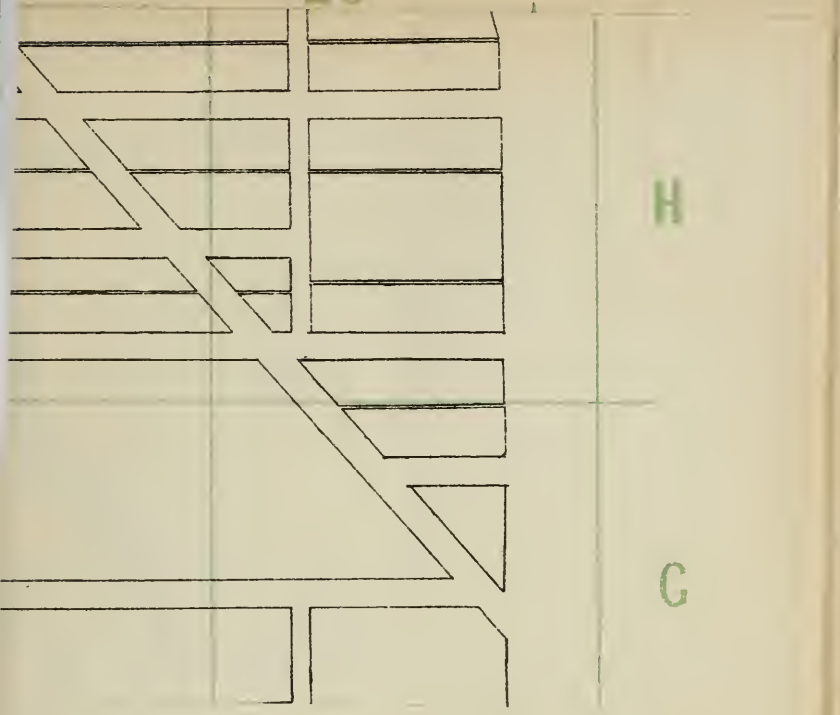
PLATE I.

27
28
29
30
31
32
20
21B
25
13A
G I
N O R T H
ROAD &
W.R. RES.
43
61
197
117
38
39
40
TERSON
S T R A I T

WOOLAMAI
WONTHAGGI NORTH
DALYSTON
ARCHIES Ck.
POWLETT R.
POWLETT RIVER
BRIDGE CREEK
DALYSTON STATION
RAILWAY FROM NYORA TO WONTHAGGI
Powlett & North Woolamai Company's Lease
WATER RESERVE
WR EXTENSION
HICKSBOROUGH
DUDLEY
DUDLEY SOUTH
EDGARTON
WONTHAGGI
Parish Boundary
For positions & information concerning bores in this area, see Plans. Plates II and III

PLAN
SHOWING SITES OF BORES
IN THE VICINITY OF
WONTHAGGI COAL FIELD
SCALE OF CHAINS
4 30 20 10 0 40 80 120
REFERENCE
Bores put down in 1917
Bores put down previous to 1917
NOTE – Explanation of boring data
No of bore
45
Surface level, 93·13
31' 0" Thickness of coal
39' Depth from surface
200' – 61' Total depth of bore. Floor level of coal above or below sea.
For positions & information concerning bores in this area, see Plans, Plates II and III
WONTHAGGI
W O N T H A G G I
RESERVE FOR PUBLIC PURPOSES 132 LINKS WIDE
COAL OUTCROP 10"
COAL OUTCROP 3'0"
COAL OUTCROP 3'0"
COAL OUTCROP 5'0"
POINT LYDIA
CAPE PATERSON
ROAD & R.R. RES.
B A S S S T R A I T

PLATE II.



POWLETT RIVER

ALLOT 21A

ALLOT 22B

ALLOT. 22A

ALLOT. 21

ALLOT. 23A

ALLOT. 23B

ALLOT 25A2

A

B

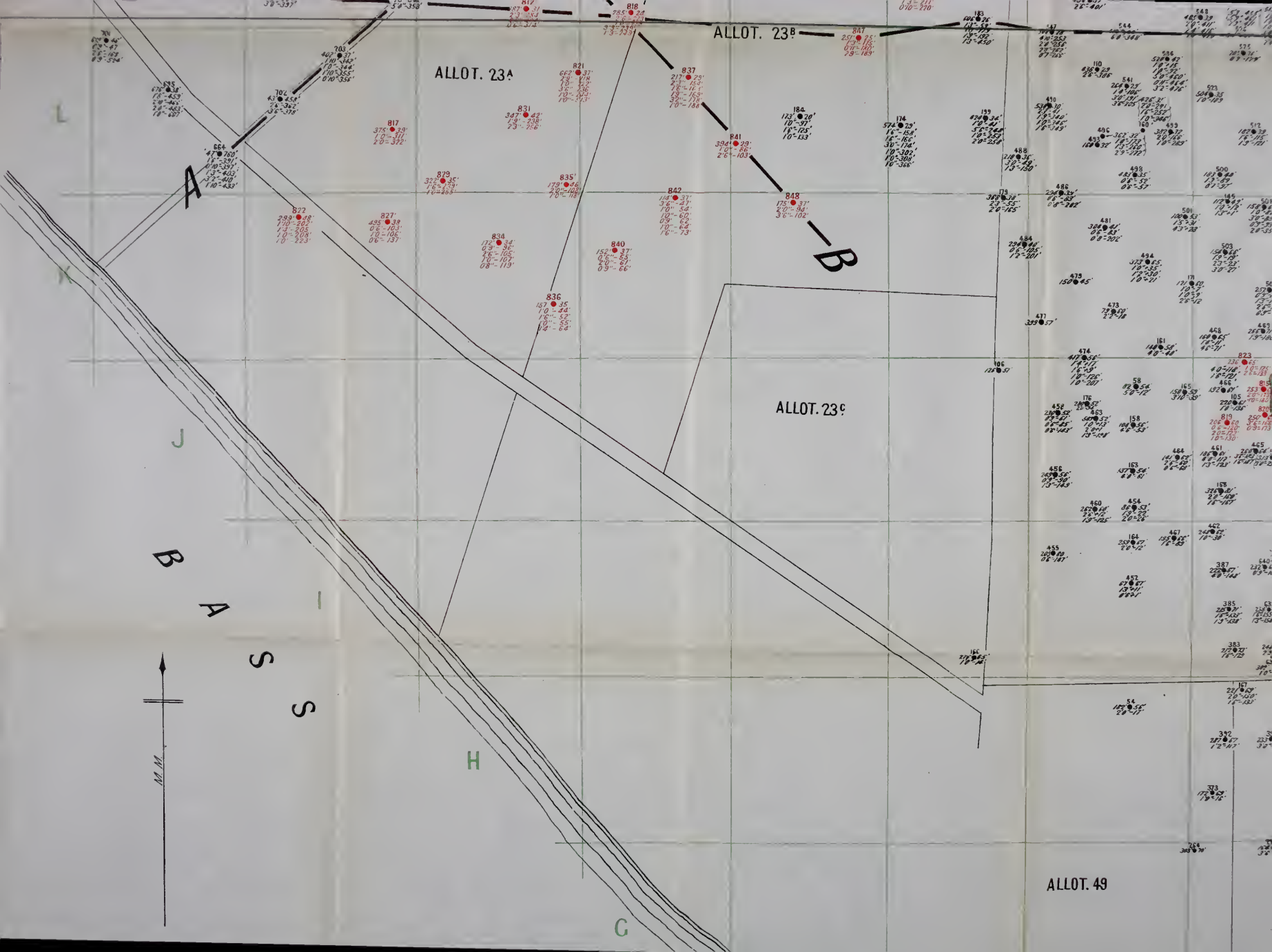
C

D

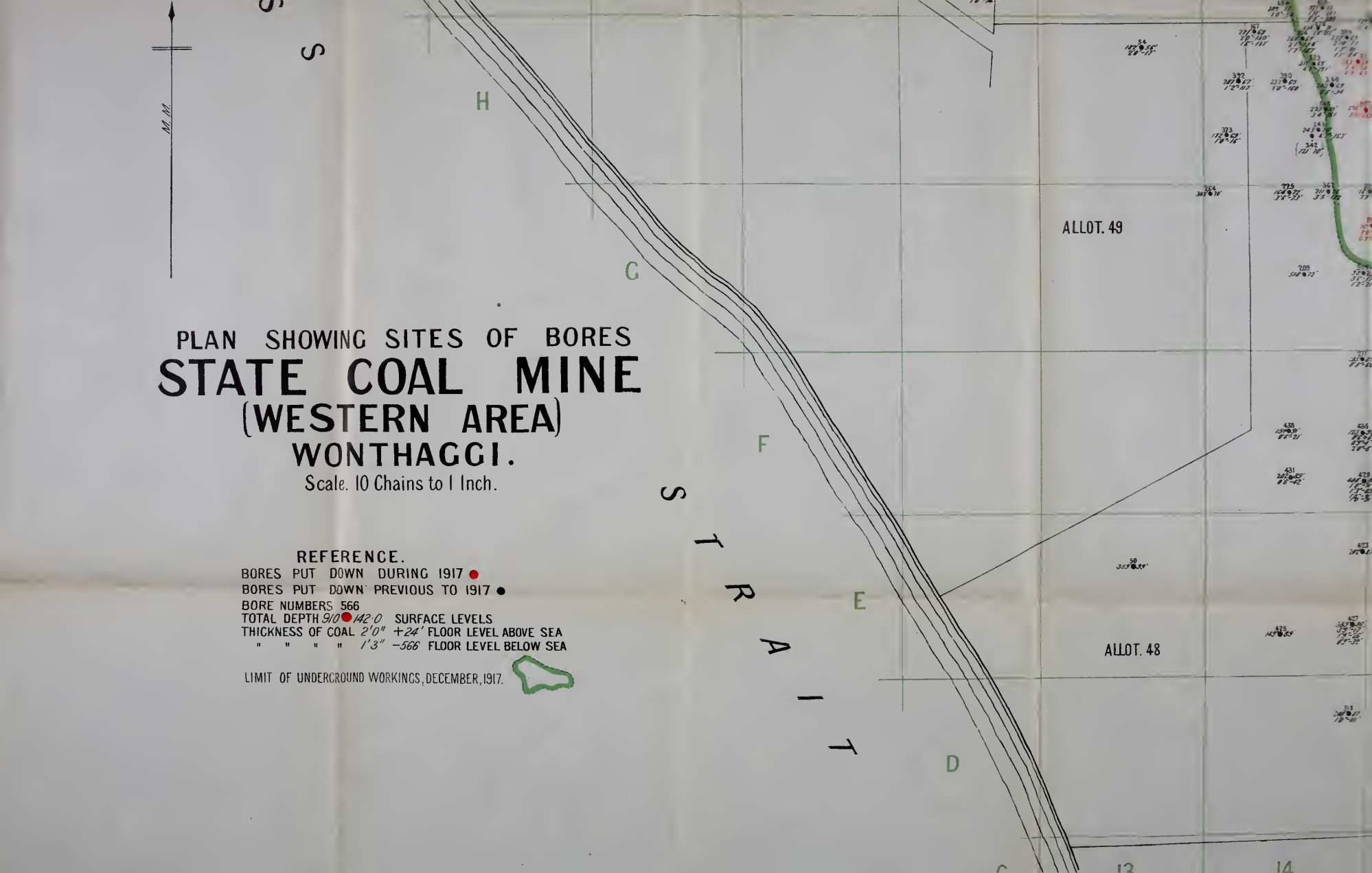
7 8 9 10 11 12 13

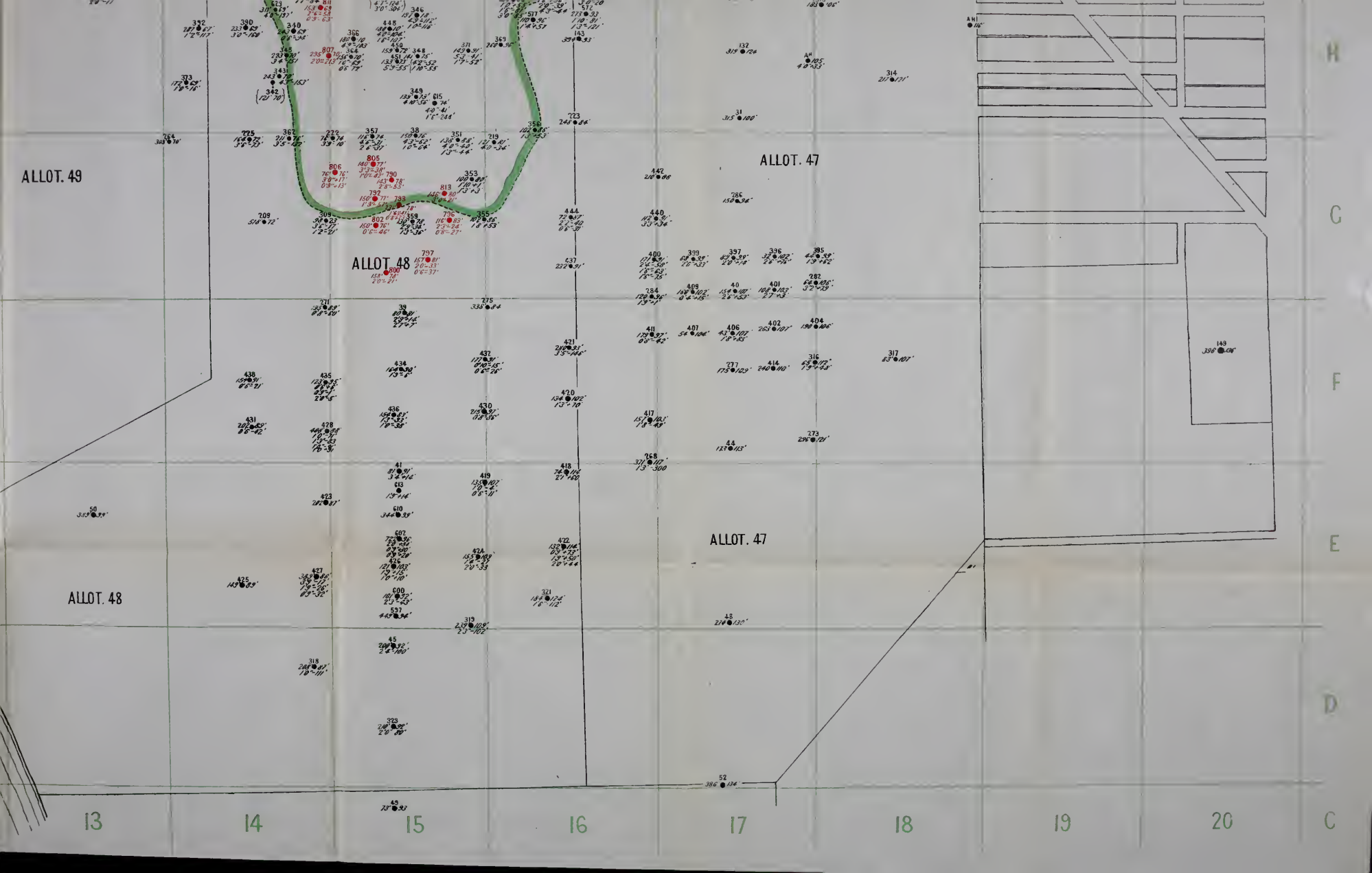
P O N M L K

14
15
16
17
18
19
20
P
O
N
M
L
K
DUDLEY
HICKSBOROUGH
DUDLEY SOUTH
SIDING
P.N.W.
C
D
MC BRIDE
LIMIT OF WORKINGS TO DEC. 1917
LIMIT OF WORKINGS TO DEC 1917
TUNNEL
ALLOT. 25A2
ALLOT. 26A
ALLOT. 26


ALLOT. 23B
ALLOT. 23A
ALLOT. 23C
ALLOT. 49
A
B
BASS
L
K
J
I
H
G
M.M.

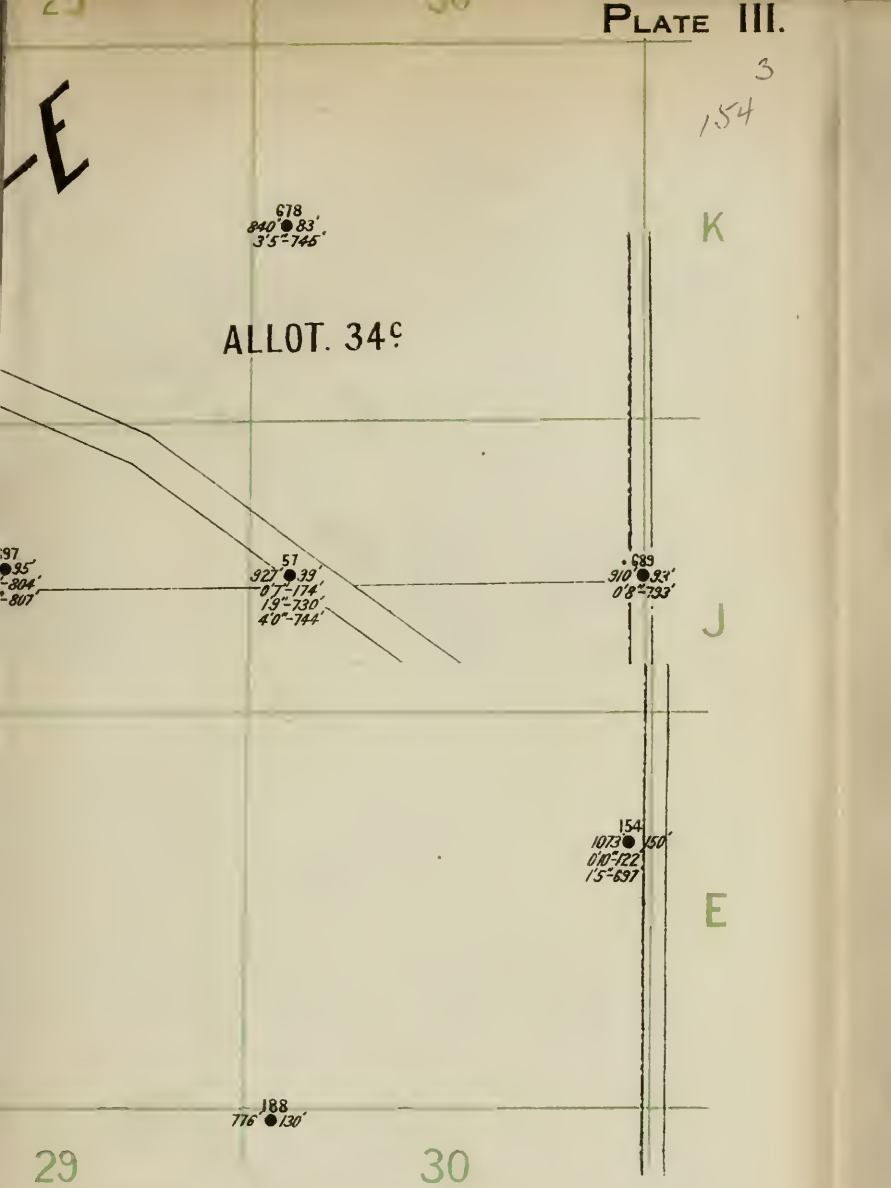
LIMIT OF WORKINGS TO DEC. 1911
ALLOT. 26A
TUNNEL
ALLOT. 26
ALLOT. 26A
AIR SHAFT
NO COAL
NO COAL
LIMIT OF WORKINGS TO DEC. 1911
ALLOT. 47
ALLOT. 48
L
K
J
I
H
C


PLAN SHOWING SITES OF BORES
STATE COAL MINE
(WESTERN AREA)
WONTHAGGI.
Scale. 10 Chains to 1 Inch.
REFERENCE.
BORES PUT DOWN DURING 1917
BORES PUT DOWN PREVIOUS TO 1917
BORE NUMBERS 566
TOTAL DEPTH 910 142·0 SURFACE LEVELS
THICKNESS OF COAL 2'0" +24' FLOOR LEVEL ABOVE SEA
" " " " 1'3" -566 FLOOR LEVEL BELOW SEA
LIMIT OF UNDERGROUND WORKINGS, DECEMBER, 1917.
ALLOT. 49
ALLOT. 48
STRAIT
H
G
F
E
D
C
13
14


ALLOT. 49
ALLOT. 48
ALLOT. 47
ALLOT. 47
ALLOT. 48
H
G
F
E
D
C
13
14
15
16
17
18
19
20

3

154


678
840 ● 83'
3'5"-746'
ALLOT. 34c
K
57
927 ● 39'
0'7"-174'
1'9"-730'
4'0"-744'
689
910 ● 53'
0'8"-793'
J
154
1073 ● 150'
0'10"-722'
1'5"-697'
E
188
776 ● 130'
29
30

21 22 23

K J I H

RAILWAY STATION

WATT STREET

McKENZIE STREET

BAILLIEU STREET

BILLSON STREET

EDGAR STREET

DICKSON STREET

DUNNE STREET

BROOME STREET

MATTHEWS STREET

MERRIN STREET

REED STREET

WONTHAGGI

ALLOT 34D

ALLOT. 35A

RACECOURSE

607 1116' ● 87'

591 121' ● 93' 588 230' ● 94'

265 511' ● 125'

270 450' ● 105'

259 435' ● 129' 0'10"-168'

266 375' 115' 2'8"-233'

230 838' ● 158' 1'0"-155' 2'8"-267'

255 370' ● 142' 2'7"-209'

487 472' ● 125' 3'6"-322'

491 584' ● 118' 2'10"-154' 3'0"-452'

252 910' ● 107' 2'6"-367'

226 152' ● 77'

216 488' ● 157'

249 481' ● 154' 3'6"-288'

471 534' ● 138'

482 532' ● 138'

56 553' ● 125' 3'-400' 3'8"-425'

576 539' ● 123' 1'0"-64'

108 540' ● 150' 1'6"-310'

581 Faulted

585 562' ● 98' 251' ● 37' 2'9"-4'

274

589 1158' ● 95' 1'6"-1032' 1'4"-1051'

599 585' ● 94' 1'0"-13' 1'0"-332' 1'0"-698' 0'5"-713' 0'6"-715'

102 335' ● 108'

502 757' ● 88' 2'7"-189' 3'3"-656'

517 722' ● 93' 2'0"-153' 3'1"-623'

138 865' ● 101' 1'2"-161' 2'10"-691' 1'4"-616'

495 800' ● 104' 0'7"-134' 3'5"-692'

511 752' ● 97' 2'0"-114' 3'5"-652'

524 722' ● 105' 2'4"-140' 3'0"-600'

583 804' ● 108' 3'0"-114' 3'2"-692'

497 800' ● 113' 1'6"-90' 3'6"-638'

528 ● 2'6"-67' 3'5"-657'

543 ● 1'5"-55'

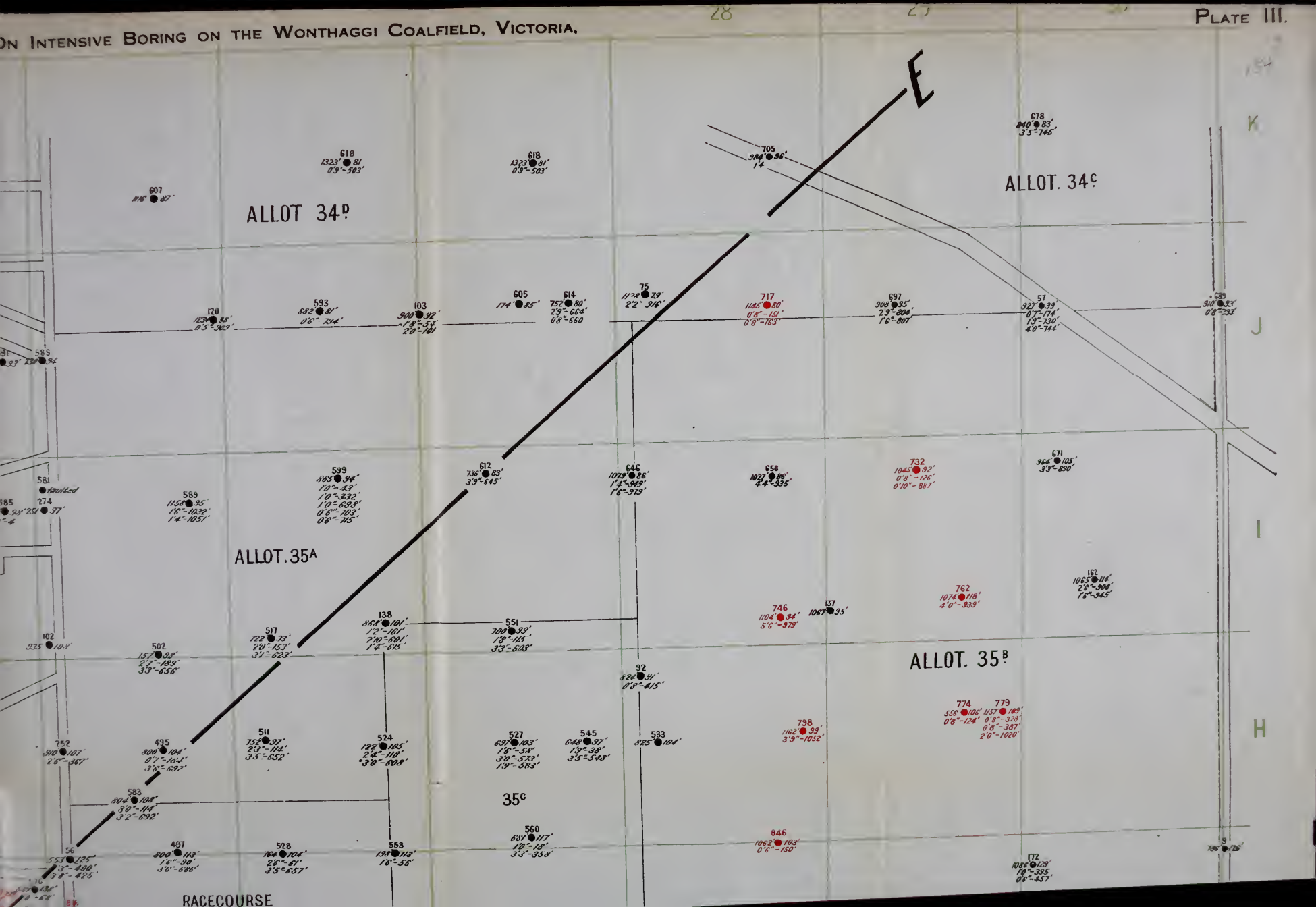
828 ● 816 ● 136'

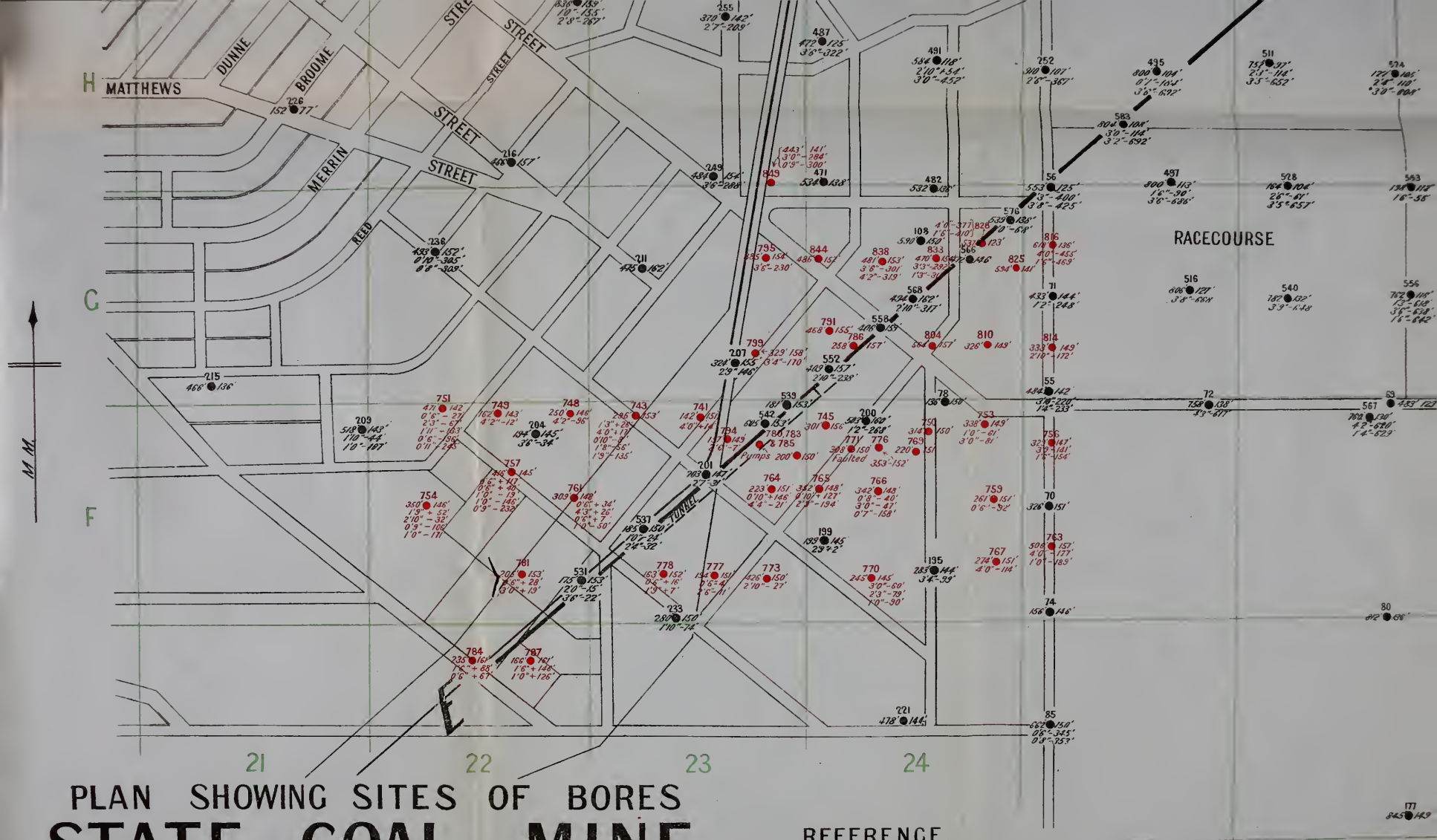
120 1234' ● 88' 1'1.5"-302'

593 882' ● 81' 0'6"-234'

512 1321' ● 21 0'3"-503'

ON INTENSIVE BORING ON THE WONTHAGGI COALFIELD, VICTORIA.





PLAN SHOWING SITES OF BORES

STATE COAL MINE

(EASTERN AREA)

WONTHAGGI.

Scale. 10 Chains to 1 Inch.

REFERENCE.

BORES PUT DOWN DURING 1917 ●

BORES PUT DOWN PREVIOUS TO 1917 ●

BORE NUMBER 566

TOTAL DEPTH 910 ● 142·0 SURFACE LEVEL

THICKNESS OF COAL 2'0" +24' FLOOR LEVEL ABOVE SEA

" " " " 1'3" −566' FLOOR LEVEL BELOW SEA

RACECOURSE

35c

ALLOT. 36

Faulted

Faulted

Silurian at -688'

H

C

F

E

1917 ●

S TO 1917 ●

ACE LEVEL

FLOOR LEVEL ABOVE SEA

FLOOR LEVEL BELOW SEA

25 26 27 28 29 30

ON A NEW PHOSPHATE DEPOSIT IN THE HOWQUA DISTRICT, NEAR MANSFIELD, VICTORIA.

By Ernest W. Skeats and E. O. Teale.

Contents.

1. Introduction.
2. Position and access.
3. Physiographic features.
4. General geology.
5. Relation of phosphate deposit to Upper Ordovician graptolitic slates.
6. Description of phosphate bed.
7. Chemical composition of phosphate breccia.
8. Conclusions.
9. Bibliography.

1.—Introduction.

The purpose of the present communication is to put on record the discovery, in October, 1916, in the Howqua district, of a new locality for the occurrence of phosphatic rocks in Victoria, and to give a preliminary description of its characters and geological occurrence. Owing to the great use of superphosphates for agricultural purposes in recent years in Australia, search has been stimulated for the discovery of local and workable supplies of phosphatic rocks. Phosphorus is an element very widely distributed in igneous rocks, usually in the form of the mineral apatite, and also occurs in sedimentary rocks and in soils as a detrital constituent. Under these conditions of occurrence, however, the amount of P_2O_5 present in a rock or soil seldom approaches, and very rarely exceeds, 1 %. Very occasionally it occurs in such a concentrated form as to constitute workable deposits. In such cases they are usually of organic origin. Sometimes they occur as geologically recent deposits of guano or rock-

[This paper is separately bound, and may be, if so desired, detached complete from this number.]

phosphate, as in certain Oceanic islands, such as Christmas Island and Ocean Island. Another mode of occurrence is among older marine sediments as mechanical concentrates of fossils with highly phosphatic skeletons, more or less enriched by secondary alteration, and in such cases frequently occurring under conditions suggesting its assemblage and concentration under the action of currents.

Victorian occurrences both of inorganic and of organic origin are known. All Victorian igneous rocks contain apatite, and all sediments and soils have phosphorus present in them in small amount. Most Victorian soils have a very low phosphorus content. Among the igneous rocks the basic rocks, like the basalts, appear to contain the largest amount of phosphorus, but even these show usually a phosphorus content of a small fraction of 1 %. Among the basic alkali rocks of the Macedon district, however, two rock types, Macedonite and Woodendite,[1] have been shown to yield about $1\frac{1}{4}$ % of P_2O_5. The mineral vivianite, the hydrated phosphate of iron, occurs in Victoria probably as an alteration-product derived from the reaction of ferruginous solutions on apatite in basalts. Such a mode of occurrence is to be found at the base of the basalt at the Wannon Falls, among other localities.

In these inorganic occurrences, however, the phosphorus content is so low as to preclude the probability of any of them becoming productive sources of phosphorus. Among organic deposits of phosphates in marine sediments in Victoria occurrences are known both from the Kainozoic and from the Older Palæozoic sediments.

Small deposits of bats' guano and occurrences of the rare mineral struvite have been recorded from caves at Skipton. Kainozoic brown iron ores (limonite) from Brandy Creek and many other localities in South Gippsland have been shown to contain phosphates of iron, lime, and aluminium.[2]

In the Kalimnan series of Lower Pliocene (?) age the base of the deposit locally consists of a thin conglomerate containing mammalian and fish bones and rolled or concretionary nodules

[1] [2] See Bibliography, pp. 164, 165.

of phosphatic material. Such phosphatic nodules are known to occur near Beaumaris, at Muddy Creek (near Hamilton),[3] and along the coast at Curlewis, about 8 miles from Geelong. No analyses of these phosphatic nodules have yet been published, and at present, therefore, it is impossible to say whether they are likely to become of any economic importance.

In the Balcombian series of Oligocene (?) age, near Mornington, marls occur along the coast, and contain calcareous nodules.[4] Five analyses of these nodules have been published, but the richest contained only 1.66 % of P_2O_5. If further search discloses high-grade material, the bed in which the nodules occur might become of economic value. Among the Older Palæozoic rocks thin seams of turquoise, the hydrated phosphate of aluminium and copper, have been recorded from Upper Ordovician rocks near Edi and Myrrhee, in North-East Victoria.[5]

The credit for the discovery of the first workable deposit of phosphate in Victoria belongs to Mr. A. M. Howitt, of the Geological Survey. The occurrence is about 3 miles south-west of Mansfield, and a Cambrian (?) age was suggested for the deposits and a comparison with the Heathcotian series was instituted.[6]

In 1909 one of the authors (E. W. Skeats), with Dr. Summers, found a number of graptolites associated with the phosphate beds near Mansfield, including both Lower Ordovician and Upper Ordovician forms.[7]

Dr. Fenner has made a brief reference to these deposits.[8]

The deposits have been worked for a few years, and numerous sections are exposed, which, it is understood, are to be the subject of a further paper from Mr. Howitt.

The area with which this paper deals was visited by Mr. Howitt in 1905 to investigate the occurrence of a specimen of phosphate picked up near the Great Rand Gold mine, in the Howqua district, and forwarded to the Geological Survey.

In one day's field work Mr. Howitt recorded a number of interesting geological observations, but did not in the limited time available find any phosphate *in situ*.[9]

3 4 5 6 7 8 9 See Bibliography, pp. 164 ,165.

2.—Position and Access.

The area in which the phosphate bed occurs lies about 22 miles by road south-east from Mansfield, a railway terminus at an elevation of 1036 ft., situated about 131 miles by railway north-east of Melbourne. The road is good for 12 miles, as far as Merrijig, on the Delatite River, but beyond this it consists of a little-used track in poor repair, which rises over the shoulder of a ridge leading to Mount Timbertop, and thence drops down into the deep mountain valley of the Howqua River. A wooden foot-bridge crosses the Howqua River (1770′ by aneroid) at Fry's house, about half a mile from the now abandoned Great Rand gold mine. The phosphate bed occurs on a ridge (2620′ by aneroid) about 850′ above the Howqua River at Fry's, and distant from it about three-quarters of a mile nearly in a south-east direction. It is less than half a mile a little west of south from the abandoned Great Rand mine. There is no road and no defined track leading directly from Fry's to the ridge on which the phosphate occurs, but an old mining track from Fry's passes within a quarter of a mile north-west of the phosphate, and leads from the Howqua River at Fry's past Ware's to the Jamieson River.

3.—Physiographic Features.

The Howqua phosphate area lies near the northern edge of the central highland belt of Victoria and close to the edge of the prominent sunk land of the Mansfield district, described by Fenner.[8] The highland consists of a very heavily dissected plateau. The main divide of this part of Victoria, at an elevation frequently exceeding 5000 ft., lies about 20 to 30 miles away to the east and south-east. Mount Buller, 5911 ft., about 7 miles north-east of the phosphate deposit, with its basalt-capped summit, forms a remnant of the old plateau, with the valleys of the Delatite and of the Howqua on either side trenched into it to a depth of 4000 ft., and exposing a complex of highly-folded and crumpled Older Palæozoic rocks. The area is therefore one with the

[8] See Bibliography, pp. 164, 165.

characteristic topography of a mountainous district, with deep youthful valleys more or less V-shaped in cross-section, and steep, narrow ridges separating the streams.

4.—General Geology.

Brief references only need be made to the general geology of the district, since one of the authors (E. O. Teale) is preparing

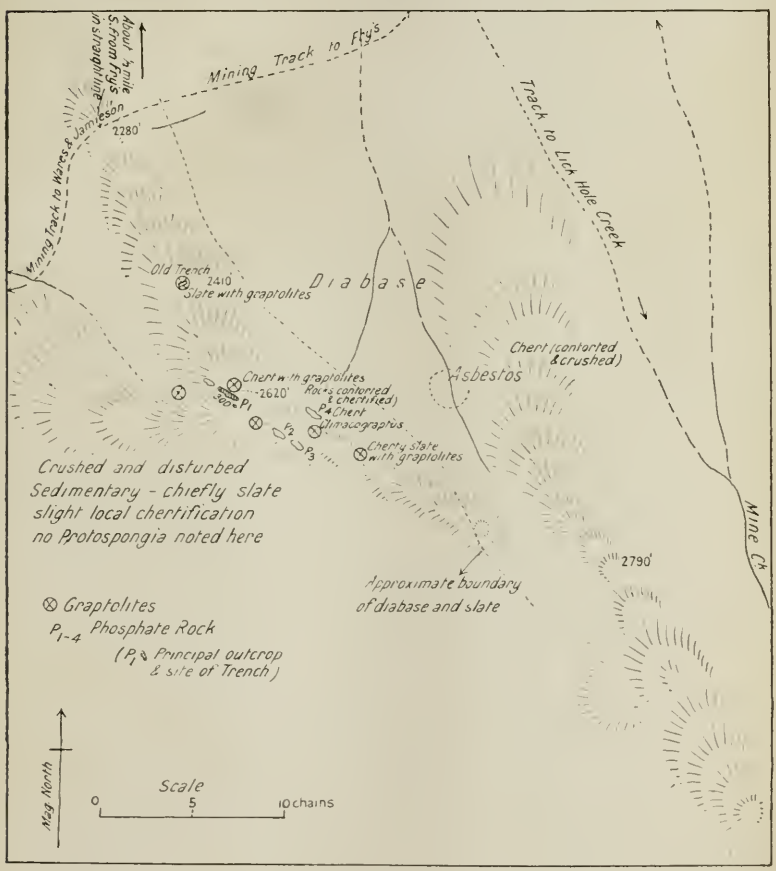


Fig. 1.
Geological Sketch Map of District.

for publication a detailed account of the geological problems of the Howqua area.

The rocks range in age from Cambrian (Heathcotian) to Upper Palæozoic, and the Older Palæozoic rocks trend across the area from north-west to south-east. The Heathcotian series consists of two belts of diabase, including also diabase ash, agglomerate, serpentine, talcose rocks, siliceo-carbonate alterations of diabase and jasperoids, while a band of massive bedded cherts with *Protospongia* trend in a north-west to south-east direction on the northerly flank of the north-eastern belt of diabase. Older Palæozoic sediments occur on the south-west flank of Mount Buller. Between the two belts of diabase is a ridge consisting mainly of crushed slates, containing *Climacograptus* and other graptolites, and probably of Upper Ordovician age. It is in this series that the phosphatic outcrops occur. Lower Devonian (?) granodiorite intrudes the older slates on the flanks of Mount Buller, and Lower Devonian (?) dacite-porphyry, resting unconformably on the older rocks, occurs in the north-western part of the area surrounding Mount Timbertop, while the capping of that mountain is formed of Upper Palæozoic rhyolites, conglomerates, sandstones, and purple shales, which rest unconformably on the dacite-porphyries.

The geological and topographical relations in the immediate neighbourhood of the phosphate deposit are shown approximately on the accompanying sketch map (fig. 1), in which the positions of the phosphate outcrops are shown in relation to the band of Upper Ordovician (?) slates among which they occur and to the belts of diabase on either side of the slates.

5.—Relation of Phosphate Deposit to Upper Ordovician (?) Graptolitic Slates.

The belt of slates among which the phosphate occurs trends roughly north-west, and its outcrop near the phosphate is about 30 chains in width. On the sketch map the junction with the southerly belt of diabase occurs just beyond the south-west corner of the map. A ridge runs parallel with the trend of the outcrop about 5 chains away from the junction with the northerly diabase

belt, and it is on this ridge that the phosphate outcrops (see fig. 1). Mr. A. M. Howitt [9] records finding a specimen of *Monograptus* west of the gully which lies north of the ridge, and apparently near the old trench which was cut in the search for phosphate *in situ* about twelve years ago. Prolonged search here failed to yield the authors any further specimens of *Monograptus*, but the material from the old trench yielded many ill-preserved forms, which are certainly diprionid. *Climacograptus* is probably represented among these forms.

On rising towards the ridge loose boulders of phosphate were found, and on the ridge four discontinuous outcrops of the phosphate *in situ* roughly trending in the direction of the ridge for about 130 yards. The outcrops have the appearance of being broken and dislocated. The rocks in general in this slate belt are much disturbed. These outcrops are shown on the sketch map as P_1, P_2, P_3, P_4. Both slates and phosphate bed have a high dip of about 80° to the south-west, the phosphate conforming in dip and strike with the slate. About a chain from the phosphate, in a south-westerly direction, and therefore stratigraphically above it, occurs a shaly mudstone with numerous poorly-preserved graptolites, while 22 ft. 6 in. north-east of the phosphate outcrop, and stratigraphically below it, a cherty slate outcrops, which also yielded abundant but poorly-preserved graptolites. No trace of monoprionid forms, such as *Monograptus*, was seen, the forms were all diprionid, and consisted chiefly of *Climacograptus* and *Diplograptus*, with probably *Glossograptus*. These forms indicate an Upper Ordovician age for the slates, and apparently for the accompanying phosphate. The finding of *Monograptus* by Mr. A. M. Howitt on the northern slopes of the ridge suggests that a small area of Silurian rocks may have been infolded or down-faulted among the older sediments by post-Silurian earth-movements. In order to be certain of the interbedded character of the phosphate bed, a trench was dug across the phosphate outcrop by one of the authors (E. O. Teale), assisted by his father, and the section thereby exposed showed

[9] See Bibliography, pp. 164, 165.

conclusively the interbedded character of the main phosphate bed, which was 7 ft. 6 in. thick, but also showed the presence of another interbedded thin phosphate band, 6 in. thick, just below

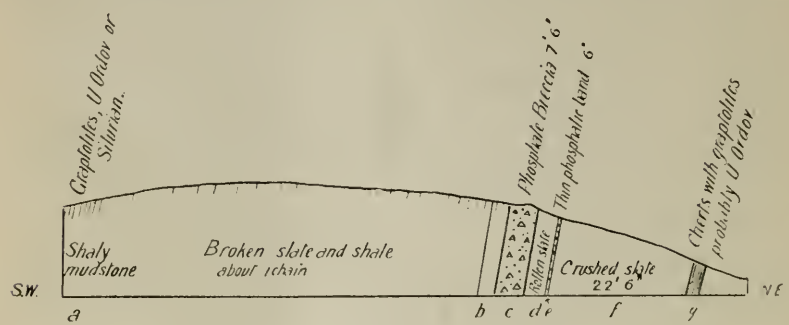


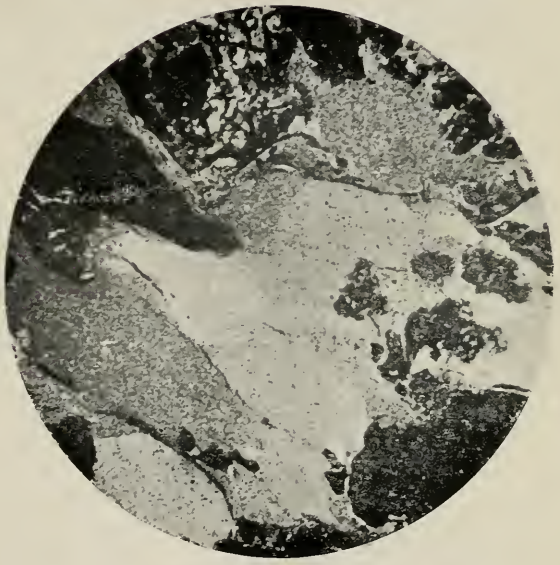
Fig. 2.
Sketch section across Phosphate Deposit.

the main bed, and separated from it by a bed of rotten slate. These relations are shown in the accompanying sketch section (fig. 2).

6.—Description of Phosphate Bed.

(*a*) *Megascopic.*—The rock is a breccia composed mainly of angular fragments, ranging from quarter of an inch in length down to microscopic dimensions. At the outcrop it is cream to ash-grey in colour, with darker — sometimes black — fragments scattered through it. Apparently fresher material beneath the surface crust is darker in colour, the black and sometimes cherty fragments being more conspicuous. Along joint-planes at the outcrop numerous thin bands of radiating crystals of wavellite, the hydrated phosphate of aluminium, are found. Many of the darker fragments are organic in origin, and have the appearance of broken and detached fragments of crustaceans. The specific gravity of the rock is 2.47.

(*b*) *Microscopic.*—Under the microscope a section of the rock analyzed shows the brecciated character clearly (see Plate I.) The fragments consist mainly of a fine shale in which minute mica flakes can be recognized. Some of the shale fragments are partially chertified. Very numerous fragments of dark brown sections of crustaceans, probably trilobites, are noticeable. Some



Microphotograph of Phosphatic Breccia, from near Howqua River, N.E. Victoria.

Ord. Light. x 18½ dia.

Showing fragmental structure. Lighter coloured fragments are shale; black areas are limonite or ferruginous phosphate in part; in part fragments of crustaceans.

reddish-brown areas have also the form of sections of crustaceans, and probably consist of ferruginous alteration-products, possibly phosphatic. Other red-brown areas are irregular in shape. Some minute patches similarly coloured are scattered through the shale fragments, while some have the shapes of sections of cubes, and no doubt are limonite pseudomorphs after pyrite.

The rock is traversed in places by minute colourless secondary veins. Some of these consist of quartz, others contain, in addition fibrous and stellate, highly polarizing crystals of wavellite.

7.—Chemical Composition of the Phosphate-Breccia.

Opportunity has not yet arisen for detailed chemical analyses of samples of the phosphatic-breccia. A partial analysis was made by one of the authors (E. O. Teale) of the specimen whose microscopic characters have been described and figured. The result is as under :—

		%
SiO_2	..	= 56.78
Fe_2O_3, Al_2O_3		= 20.95
MgO	..	= n.d.
CaO	..	= 6.6
P_2O_5	..	= 6.97
Loss by ignition		= 4.39

Iron and aluminium were not separately determined, but the iron content was low. Magnesia was not determined, but was present only in slight amount. It will be noted that the P_2O_5 content is low. The base or bases with which the phosphorus is combined have not been determined. Much of the Mansfield phosphate consists essentially of phosphate of aluminium with some iron, and this may be the form in which it is present in this rock. In this connection it is to be noted that, as in the Mansfield occurrence, wavellite occurs along joint-planes in the rock. However, lime is present in such quantity as would almost satisfy the phosphorus present if they were combined. It is possible, therefore, that the phosphorus may be present—at any rate in part

—as phosphate of lime, and this is consistent with the abundance of crustacean remains, whose skeletons in large measure consist of calcium phosphate.

8. Conclusions.

Present knowledge of the deposit does not encourage much hope that it will prove of economic importance. The result of the single partial analysis showing less than 7 % of P_2O_5 compares unfavourably with the analyses of the Mansfield deposit, in which considerable quantities of material, ranging from 15 % to over 20 % of P_2O_5 have been developed. However, it may be that much higher-grade material may be present in the Howqua deposit and remains to be discovered. With present knowledge it seems to be quite probable that the loose specimen analyzed by the Geological Survey of Victoria 12 or 13 years ago, and yielding over 15 % of P_2O_5, actually came from the Howqua deposit.

The discovered outcrops are of limited extent, and further prospecting and a considerable amount of trenching and sinking would be necessary to prove the extent and value of the deposit. Even if a considerable body of high-grade phosphate were eventually located, its position in a remote region, 23 miles from Mansfield railway station, with no present road to the Howqua River and a poor road to Merrijig, would impose high cost of transport as compared with the more favourably situated deposit near Mansfield.

9. Bibliography.

1.—E. W. Skeats and H. S. Summers, "The Geology and Petrology of the Macedon District." Geol. Surv. of Vict., Bull. 24 (1912), p. 31.

2.—Cosmo Newbury, "Laboratory Notes." Geol. Surv. of Vict., Prog. Rep. No. 5 (1878). pp. 182, 183.

3.—F. Chapman, "Mem. Nat. Mus., Melb.," No. 5 (1914), p. 47.

4.—R. A. Keble, "The Mornington Marl Deposits." Geol. Surv. of Vict. Records, vol. iv., part 1 (1917), p. 58.

5.—A. M. Howitt, "Report on the Edi–Myrrhee Turquoise Belt and the Chert and Jasper Beds near Tatong, County of Delatite," with plan (Plate XXIV.) Geol. Surv. of Vict. Records, vol. i., part 4 (1906), pp. 239–241.

6.—A. M. Howitt, "Reports on the Phosphate of Alumina Beds, near Mansfield, County of Delatite," with plan (Plate XXVII.). Geol. Surv. of Vict. Records, vol. i., part 4 (1906), pp. 245–247.

7.—E. W. Skeats, Pres. Address, Sec. C, Aust. Assoc. Adv. of Science, Brisbane, 1909, pp. 177, 178.

8.—C. Fenner, "Physiography of the Mansfield District." Proc. Roy. Soc. of Victoria, vol. xxvi. (n.s.). part 2 (1914).

9.—A. M. Howitt, "Report on Alleged Discovery of Phosphate of Alumina near the Great Rand Gold Mine, Howqua River, County of Wonnangatta." Geol. Surv. of Vict. Records, vol. ii., part 4 (1907), pp. 169, 170.

DISCUSSION.

Mr. L. Keith Ward asked whether there was any evidence with regard to the period at which segregation of the phosphatic material had taken place in the breccia. There was a difference, he thought, between the age of the rocks with which the material was associated and the age of the deposited material. It was a matter of practical importance. The Cambrian rocks in South Australia were overlain by late Tertiary rocks, the phosphatic deposits being found in the Cambrian rocks, sometimes in perished breccia, the latter being connected with Cambrian limestone. The Tertiary river-gravels overlay the phosphatic deposits themselves, and without exception those phosphatic deposits lay very much above the bottom of the present level of the river-systems—that is, in the bottom of the present valleys carrying Cambrian deposits there was no chance of seeing any phosphatic deposits; they were to be found high up on the flanks of the

hills, and capped by Tertiary alluvials. That was significant. Apparently there was some relation—and Mr. Jack had worked it out—between these and the accumulations of phosphatic material in those perished breccias and in the cavities in the Cambrian limestone. They had very large deposits in South Australia, from the neighbourhood of Noarlunga, in the south, to a point 200 miles northwards, near Carrieton. Some have been worked, and, though none of the deposits were of a high grade, many were workable, and they looked forward to the development of these domestic phosphatic resources in the future. The Agricultural Department was co-operating with the Department of Mines in South Australia, and they were trying new methods of applying the lower-grade rock, without proposing to put it through the same expensive treatment as for the production of superphosphate.

Mr. A. S. Kenyon said there was a practical side to the matter. The deposit described by Professor Skeats was too poor and too inaccessible to be used at present. The other deposits of alumina phosphate near Mansfield averaged 15 % phosphoric acid and were utilized very successfully by special process. It might interest those members who did not know Victorian conditions to be informed that it was so far done simply by mechanical means, viz.: by roasting followed by very fine grinding. An attempt would be made to turn out a super or water-soluble phosphate, also by a special process. After four or five years' experience with the carefully roasted and ground phosphate, the orders from farmers were continually repeated and increased. The result of careful roasting and fine grinding had been to render chemically available to plants the otherwise refractory phosphates. It was quite likely that the exceedingly fine grinding of the slag cement mentioned in Mr. Poole's paper had somewhat similar results. At any rate, successful results followed the treatment of Mansfield phosphatic rock. Exceedingly fine particles of alumina phosphate were apparently soluble in the soil solution by the treatment mentioned, whereas they were insoluble under ordinary conditions.

Mr. Ward said that in South Australia they had their lower-grade tricalcic phosphate and also the aluminum phosphate ground. One of the cement-grinding companies treated it, and 96.5 % of the phosphate would go through a 100-mesh sieve. He thought that American practice claimed that at least 90 % should pass through a 100-mesh sieve. In South Australia they had got it distinctly finer, and it was being tested in various ways at the present time. But he would like to add that great care had to be taken as to the region in which the experiments were made. Must there not be a reasonable rainfall? The American practice has been to use the raw phosphatic rocks, which must be finely ground, and the experience there was that they must be used in regions where the rainfall was at least 20 in. per annum. In South Australia they had much country with a rainfall of only 10 in. per year, and that restricted the use of phosphate in that State to the south-eastern portion and the Mount Lofty Ranges.

Mr. Kenyon said one hundred mesh was not fine enough grinding for successful results with these clay phosphates. Commercially it had been found very difficult to obtain a much finer finish than 180 mesh, whereas 200 mesh had been the aim. Without the roasting that fine grinding would be impracticable in large quantities. The trouble so far had been the exceedingly minute grinding and the difficulty in getting workmen to attend to the appliances, but as far as the output could be maintained the orders have been continually repeated. As to rainfall, the general conclusion was that with a 20 in. average, the clay phosphate in a finely-ground state gave better results in certain sandy soils, such as those of South Australia, than in clay soils; and with certain black soils in areas with a 12 in. to 15 in. rainfall it gave as good results as in those with 20 in. South Australia and Victorian Mallee soils were calciferous and sandy, but were almost completely devoid of humus. The remarkable result followed that the use of phosphate was very profitable, while there was little or no improvement of the grain yield with the use of nitrogenous and potassic manures.

Mr. Wm. Poole: Mr. Ward mentioned that 96 %, roughly, went through a 100-mesh sieve. To arrive at that they took a certain analysis, although it would be found that 80 to 85 % would go through a 200-mesh sieve—that is, the bulk of it would be finer than ordinary flour, and it was called slimes in ordinary work. If they had difficulty, it might be because they did not dry the material so as to be able to grind it properly; but if they used the latest fine-grinding apparatus he did not see that there could be any difficulty in arriving at that degree of fineness. As to the solubility of the material, the humid acids and other natural acids which occurred in certain soils were capable of breaking up insoluble materials like the felspars, because the plants derived their potash from felspars which, under ordinary laboratory conditions, were considered to be practically insoluble. That is, special means had to be taken to make them soluble. That takes place in nature, and in connection with these natural phosphates, but on a more accentuated scale.

Mr. Ward: With regard to the point that Mr. Poole had made as to the degree of fineness to which that material had been meshed, they had a complete analysis made, which proved that about 70 % would pass a 200 mesh and 96½ % of the whole would go through a 100 mesh. There had been considerable controversy on the influence of rainfall, and he thought a very great deal of the prejudice against the use of raw phosphate in the drier areas was due to the fact that it had been put through a 20-mesh sieve instead of through a 150 to 200-mesh sieve. It had not been a test of the material in its proper form. Americans contended that the organic constituents of the soils played a very important part in the solution of the raw phosphate. They had attempted in some cases to plough-in clover, which necessitated a high rainfall, and so they had restricted their operations to areas where clover could be grown. The other alternative was to use farmyard manure. Unfortunately, they had none of that there, because the stock were not kept in farmyards in winter time.

Mr. Kenyon: South Australian soils were calciferous, sandy soils; and Victorian soils were not so calciferous, but were almost completely devoid of humus. The organic matter of leaves and stubble was disintegrated into its chemical compounds in the immediate form of humus. That was one of the typical things in connection with Victorian wheat soils, and one of the remarkable results of the use of superphosphate was shown in the reduction in the use of nitrates and potashes.

Mr. D. N. Morison said in their business they had difficulty, some time ago, because of the war conditions. They were confined to the use of a certain amount of pig-iron produced locally, which was deficient in phosphorus, and so lacking in fluidity. They made search in order to find some iron ore containing phosphorus to mix with the metal to be used in the castings in order to get the necessary fluidity, and they found that it was the practice in one of the blast furnaces of New South Wales to use phosphatic rock. Phosphorus was deleterious in the production of steel, and a good deal of trouble arose over that. They made search in the iron-ore deposits of New South Wales, and found the rather astonishing fact that, with one single exception, the whole of the iron-ore deposits of New South Wales were deficient in phosphates, and the only iron-ore bed that had more than the usual proportion of phosphorus was situate in the catchment area of one of the great water supplies, and was prohibited from being mined. He was wondering whether that phosphate, containing a certain quantity of silica, would lend itself to the introduction of phosphorus into iron that was deficient in phosphorus.

Mr. H. Herman: Professor Skeats referred to the Mansfield rocks as Lower Ordovician. He thought the present position to be this: in the phosphate-bearing rocks were found graptolite forms which were regarded as Lower Ordovician, but which Mr. F. Chapman regarded as identical with Upper Cambrian forms. It had now to be decided whether those Upper Cambrian forms came up into the Lower Ordovician, or the Ordovician forms

descended into the Cambrian. He thought Mr. Chapman was inclined to take up the position that the formerly-regarded Lower Ordovician graptolites occurred with Upper Cambrian graptolites. As that would necessitate a re-classification of the Victorian Ordovician rocks, he did not feel inclined officially to take any step in that direction until the evidence was more convincing than at the present time. On the question of the possible leaching from one formation to another, Mr. Ward suggested that in South Australia leaching was probably closely related to the Tertiary drainage system, and that probably the segregation took place there not long before the superincumbent river alluvial was deposited. As far as Mansfield was concerned, the prospecting work had proceeded far enough to place it beyond reasonable doubt that the phosphatic rock was really bands in the Lower Ordovician or Cambrian rocks. At what period, if at any period long subsequent to the original deposition of the rocks, there was any re-arrangement by leaching, he was not prepared to say. But there was no doubt they were the original phosphatic rocks in the old rocks in which they occurred. As to the agricultural side, and the use of the roasted and ground phosphate in certain soils—in the first place, the preparation of the rock for market entailed something more than grinding. The rock was brought in by rail from Mansfield, about 130 miles distant, to the company's works at Macaulay. It was dumped from the railway trucks into driers, which fed rock-breakers, which reduced the rock to from three-quarters of an inch to dust. The crushed rock then passed into a rotary kiln about 100 ft. long, heated by producer gas from Morwell brown coal. Rock with insufficient lime had the deficiency supplied by the addition of limestone at the rock-breakers. The roasting was so regulated that the rock was dehydrated without being fused. The rock passed from the kiln to a revolving cooler, and thence to elevators, pommels, high-speed stone mills (or disintegrators), and dust pumps. The coarser particles were reduced in tube-mills. The fine dust was settled in stives, whence it was transferred to the stock bins and bagging machines. Agricultural field tests made for a number of years had shown that it was very successful in certain districts. Now there

was a demand for more than the works could produce. It was estimated that the Victorian market could absorb 10,000 to 12,000 tons per annum. The opening-up of the Mansfield deposit had led to search for similar rocks in other districts. Mr. Howitt thought that there may be repetitions of that phosphate rock on the same geological horizon elsewhere in the State.

Professor Skeats, in reply, said it was fortunate for him they had present men like Mr. Herman and Mr. Kenyon, who were able to answer questions relating to mining and the fine-grinding of the phosphate—subjects with which he was not familiar. The remarks of Mr. Poole and Mr. Ward had already been answered by those gentlemen; but no one had been game to tackle Mr. Morison's question, and he (Prof. Skeats) was not prepared with a solution either. He was glad that Mr. Herman had made a point of the discovery by Mr. Howitt of that deposit in the course of a purely geological inspection—a deposit which had proved of marketable value. It proved how valuable was the help which the organized Geological Survey was capable of yielding to the mining industry, and also, incidentally, to the agricultural industry; and it provided an additional argument for their retaining within their membership men of allied sciences who could, and did, assist one another in the course of their work. Mr. Ward had asked certain questions which served to illustrate the old truism that it was far easier to ask a question than to answer it. He asked the author for evidence as to the period in which the crustacean remains, which represented the original phosphatic contribution to that deposit, became altered by the passage through them, in solution, of other matter, so that secondary minerals, like wavelite, had been formed. He (Professor Skeats) was quite unable to give an answer. The segregation must have been subsequent to the death of those crustaceans and the formation of that crustacean cemetery, which must have occurred in the Upper Ordovician period. But the fact that it occurred in a highly-crushed zone, with intrusions of pre-Upper Devonian age, suggested that during that period of extensive earth-movement there may have been several fractures produced to allow of the

penetration of the mineral solutions. Areas had been found which had been definitely leached; but whether that leaching had been intermittent must remain largely an open question, because of the lack of knowledge.

Mr. Ward asked if the topography showed any evidence.

Professor Skeats said he was not aware of any. The older streams provided evidence at Mount Buller that the present topography was the result of a post-Miocene uplift, and possibly of a post-Pliocene uplift. Whether it would be possible to correlate that ancient system with the secondary phosphates he was not able to say. Mr. Ward's statement as to the relation of some of the phosphatic deposits of South Australia to the older physiographic features was very interesting and important. He (Prof. Skeats) might point out that, as far as he knew, in many of the phosphate deposits of the world there was evidence of current-action. Nearly all of them appeared to have been deposited in position by moderately strong currents, and many of them occurred in breccias and conglomerates. How that evidence of current-action was definitely related to phosphatic deposits was still an unsolved question. In that connection it might be interesting to note that probably of much the same horizon as that to which Mr. Ward had referred in South Australia were the Tertiary limestone series of Victoria and the late Tertiary series, of which they had evidence in Victoria at the base of the Lower Pliocene near Beaumaris and Curlewis and around Port Phillip. At the base of that material occurred pebbles, which had been analyzed and proved to be phosphatic. Whether that was on the same horizon with, or slightly higher than, the one in South Australia, he did not know.

Mr. Augustus Wolskel (at the invitation of the chairman, Newcastle meeting) wrote that the paper by Drs. Skeats and Teale had been read by him with considerable interest, as he attributed more importance to the discovery therein recorded than the authors appeared to attach to it by their comparison of the new phosphate deposit with the phosphate deposit nearer to

Mansfield. It must be kept in mind that prior to the war there was imported into Australia yearly, approximately £500,000 of phosphate rock. and that any well-accredited information was of importance which showed that Australia had resources (never mind the prima facie difficulties attached to them) capable of being utilized by improved methods of transit and changed methods of treatment. From his point of view, that of the chemist concerned with industrial mining, there were, neglecting faults and displacements, two definite lines of phosphate beds now showing in the Mansfield district ; firstly, the Mansfield or northern line in cluding Phosphate Hill ; and secondly, the Howes Creek or southern line including Griffith's Blow. Phosphate Hill had been under his control since 1913. Griffith's Blow was examined while under offer in 1916. Nearly all the samples obtained by him from the two lines had a high silica content similar to that which had led Messrs. Rankin Scott & Robertson (Victorian Agriculture Department) to conclude that the phosphates from that district as a whole should be classed as silico-alumina phosphates (with or without lime). The Howes Creek line had a brecciated structure showing at the surface and coinciding with that described by Professor Skeats as pertaining in the Howqua beds. The Howes Creek samples had a range 25 % to 1 % P_2O_5, averaging 12/15 %. Griffith's Blow on the southern line was being opened up by associated fertilizer manufacturers, and it appeared to him that the authors' discovery was on the same southern line on which that body occurred : in fact, was almost a proof that the Howes Creek line extended in some form or other for many miles. Two deductions may be drawn from the information given in the paper under consideration, plus the present knowledge of the Mansfield rocks. These were : (a) the existence (as suggested in the paper) of a higher average phosphoric acid content in the Howqua beds than was disclosed by the single sample analysed by Dr. Teale, and (b) the existence of another line of beds lying northerly of the brecciated Howqua beds, such anticipated deposit being a probable eastern extension of the Mansfield line worked at Phosphate Hill. It was also to be assumed that the anticipated deposit would be non-brecciated and

associated with quartz veins, pyrites and casts of Lower Ordovician graptolites after the manner of Phosphate Hill. Assuming these deductions to be correct, there was, therefore, covering miles of country (though not commercially continuous) a reserve store of phosphatic material which, keeping in mind the large quantity annually imported, more than ever made its application to industrial and agricultural use one of national importance. After the discovery of Phosphate Hill in 1904 by Mr. A. M. Howitt much was done to condemn and deride the Mansfield phosphate. Among other things, there were alleged against it :—(1) That the deposit was too small in extent. (2) That the average grade 15 % P_2O_5 was too low for use, and unfavorable comparisons were instituted with 38 % Ocean Island phosphate rocks. (3) That the alumina made the phosphoric acid quite insoluble ; in support of that condemnation the poor results shown by citric analysis were cited. (4) That upon fertilizer manufacturers trying the phosphate, it had not dried, or had set too hard after being mixed with acid, and blasting had to be resorted to, to remove it from the re-action dens. (5) That though the Commonwealth Government offered a bonus for phosphate discoveries, the bonus could not be given to phosphates containing more alumina and less phosphoric acid than local trade usage approved. The last objection (5) was still a bar and the Mansfield phosphate remains outside the regulations of the Bonus Act. Though its original reputation was such that it had to be manufactured and then given away to induce farmers to even try it during its first season, yet it has commanded an increasing sale since 1916, and, of more importance than the bonus, it is now receiving the financial support of farmers' societies, because gradually it was being recognized ;—(1) That the deposit was not so small. (2) That though Ocean Island phosphate was exceptionally rich, still in the course of manufacture it was broken down until the original 38 % P_2O_5 became 18 %. As standard European fertilizers also often contained but 13 % P_2O_5 ; high phosphatic contents cannot be a necessity for agricultural purposes. (3) It had further been recognized that the deductions drawn from hypothetical methods of analysis may be highly

delusive and the term "insoluble" if applied to any commercial substance should mean "insoluble under conditions of ordinary use." Laboratory tests of phosphates based on hypothetical commercial standards became ridiculous when the condemned phosphate grew crops under fair conditions. (4) That the manufacturing troubles were avoidable, and information concerning the processes preferred by the writer can be obtained in Commonwealth Patents Nos. 18,290/15, 571/16, 2375/16, 4786/17 and 730/16 (void). As a substantial aid in eliminating one of the several false notions with which the Mansfield phosphate deposits have been enshrouded, he welcomed the authors' informative contribution on their discovery at Howqua.

NOTES ON THE BLAIR ATHOL (QUEENSLAND) COAL-FIELD.

By J. F. Hall.

The following short paper on the Blair Athol coal-field will no doubt have a twofold interest to members from the fact that its main seam, known as the "Big Seam," of a maximum thickness of 91 ft. without a band, is unique, being probably the thickest seam of high-grade clean coal yet known, and also because of the interesting problem it presents the colliery engineer—viz., which system of mining is the best to secure the highest economical extraction ?

Location.—Blair Athol is a mining to wnshipin Central Queensland, situated at an altitude of about 1100 ft. above sea-level at the end of a branch railway line 74 miles from Emerald, on the Main Central Western line, and 240 miles by rail from Rockhampton.

Geology.—The coal-measures appear to lie in a shallow basin of about four or five square miles in area, surrounded on all sides by slates and schists, which are overlaid on three sides by alluvial deposits of up to 150 ft. in thickness, and on the fourth by a thick basalt bed, as yet unproved, some miles beyond which the auriferous slates outcrop.

These alluvial deposits have been largely worked in years past and gave high gold returns, the chief diggings being Clermont and Macdonald's Flats in the south, the Springs and Black Ridge in the north-east, and Yankee Creek and others on the west. The surface of the coal-fields may be described as unbroken, but undulating, with gentle southerly dip, the watercourses opening out into wide flats. The absence of creeks or deep gullies accounts for no outcrops being visible on the surface, and the coal-measures

[This paper is separately bound, and may be, if so desired, detached complete from this number.]

are covered by decomposed basaltic soils on the southern edge of the coal basin, where the slate beds are seen to be dipping at a high angle beneath the overlying strata of the coal beds.

From the presence of the fossil fern *Glossopteris*, which is found in places above the coal seams and abundantly in the fireclay immediately below the "Big Seam," the geological age is indicated to be Palæozoic, and classified as Upper Permo-Carboniferous.

History.—Coal was first discovered in the year 1864 in sinking a well for water on the Blair Athol freehold block, and an accidental discovery in this manner was required, as there is absolutely no surface indication to show that coal seams exist below. Following on this, bores were put down by the Peak Downs Copper Mining Co., and the first Blair Athol colliery opened in 1892, followed by the Hope, Eldorado, and Imbell collieries. These mines worked chiefly the top or "Little Seam" to a very limited extent, and carted the coal to the railway station at Clermont, about 12 miles south. In 1910 the railway was extended to Blair Athol, and the Blair Athol Coal and Timber Co. Ltd., which was formed about this time, began work, and has now three collieries working on up-to-date lines. In 1913 the Newcastle Coal Co. Ltd. commenced mining operations on new ground north of Blair Athol, and has now two well-equipped collieries working. In 1915 the Co-operative colliery was opened on the southern edge of the coal basin by a party of miners working under tribute from the Bluff Coal Co. Ltd., but, owing to the surface subsiding during the heavy rains of January, 1917, the workings became flooded and the mine was lost. During the year 1918 a fresh mine was opened on this lease by the Bluff Co., and is now coming into the producing stage.

Coal Seams.—The coal-measures carry three profitable seams, the upper two of which are now being worked, the top or "Little Seam," so far proved over about half the above area, being a bright bituminous coal of up to 7 ft. in thickness, with, in places, a band of stone about 2 in. thick in the middle. Below this small seam, at a varying depth of from 3 ft. to 30 ft., occurs the main "Big Seam" of from 40 ft. to 91 ft. thick of clean coal,

without bands. On the southern edge of the coal basin this seam, as cut in the Co-operative shaft, is 40 ft. thick, and about two miles north it is 72 ft. thick in the Newcastle east shaft. At the Newcastle west shaft, half a mile west of the east shaft, it is 61½ ft. thick, while in the Blair Athol mines, which lie between the Co-operative and Newcastle collieries, it is proved at varying thicknesses from 48 ft. to 91 ft.

The seam is entirely free from stone bands, but there are occasional floating lenticular beds of a soft "duff" found irregularly throughout it. These "duff" beds might be likened to the ironstone boulders or "brass" which is found in some southern seams, but here they are composed of a soft earthy material, and can be easily separated from the coal. A sample of this "duff" recently analyzed gave the following result:—Moisture 28 %, ash 3.3 %, combustible matter 68.7 %.

Well-defined bedding-planes occur throughout the seam, and greatly assist in mining, forming excellent roof and floors, but a characteristic of this seam is the absence of the vertical planes, "cleets," or "backs" usually found in coal seams. In the Blair Athol No. 1 colliery the coal is undercut by electrically-driven coal cutters, but in the other collieries it is "grunched" or shot from the solid, and yields well from the good bedding-planes. Being a strong, hard coal, it requires explosives to break it, and the seam produces a high percentage of "round coal."

Samples carefully taken by the writer from Newcastle east pit by 5-ft. sections through the full seam were put up in separate air-tight tins and sent to the Naval Department for individual analysis. The result showed a marked uniformity of the whole section, the greatest difference between the 14 analyses in fixed carbon being 57.21 and 62.96, and in ash content 7.72 and 4.27. The average of the whole seam was:—Moisture 9.00, fixed carbon 59.38, vol. hydro-carbons 25.26, ash 6.32, sulphur 0.35. A later analysis of mixed samples from all working faces gave the following result:—Moisture 6.34, fixed carbon 58.99, vol. hydro-carbons 28.94, ash 5.81. The specific gravity is 1.394.

The coal has a dull, lustreless appearance; it is non-coking, practically smokeless, and burns brightly to a fine white ash without clinker. Being a hard, non-friable coal, it carries well, and suffers little or no deterioration by storage, and therefore would make an admirable shipping coal. The seam carries a moderate quantity of water; the flow in the Newcastle east shaft (which is the deepest on the field) is about 3000 gal. per hour. A remarkable feature is that this water, unlike the water usually met with in coal mines, is quite fresh and wholesome, being very suitable for boiler and domestic uses. The Railway Department draws its locomotive water-supply from the mines, and, during the last drought, took large quantities for the use of the settlers on the Central line, taking as much as 37,000 gal. in a single train-load.

Below the "Big Seam" a third small seam has been proved at two or three places, but, being of similar quality to the "Big Seam," has not been worked. At one point it is found a distance of 34 ft. 8 in. under the "Big Seam," and is 7 ft. thick, with three bands of stone, and at another place it is 106 ft. below the "Big Seam," and is 4 ft. 2 in. in thickness, and clean coal. The proved depths of the overburden above the coal seams vary from 133 ft. in the Newcastle east shaft to 40 ft. as cut by the Co-operative shaft, and probably will be found at even shallower depths at other points. The section of strata in the first-named shaft is as follows:—Black soil, 6 ft.; decomposed basalt, with boulders, 34 ft.; sandstone (soft), 20 ft.; sandstone intermixed with limestone (strong), 40 ft.; fireclay, 6 ft.; sandstone (soft), 20 ft.; mudstone, 7 ft. The measures overlying the seam at the other mines vary much in character, but chalky sandstones predominate.

General Remarks.—The present output of the field is about 150,000 tons per year, and is practically all produced from the "Big Seam." The market is purely a local one, as, owing to distance from the port of Rockhampton and the absence of loading facilities, no shipping trade is done. All the mines are working the coal by the "bord and pillar" method, the workings

at Newcastle collieries being laid out strictly on the panel system, with barriers one chain thick between districts. The average height of the working places is about 10 ft. (the bedding-planes in each individual place regulating this), and it is proposed to work this thick seam by a series of lifts commencing at the top of the seam, and leaving a suitable thickness of coal for a roof for the succeeding lift. Thus, assuming a total thickness of 74 ft., and an average thickness of 6 ft. to be left in between each lift or working section, there would be five distinct workings of 10 ft. each = 50 ft., and four bands of coal of 6 ft. each left in between the lifts = 24 ft. Where the seam is, say, 58 ft. thick, there would be four lifts of 10 ft. = 40 ft., and three bands left in of 6 ft. = 18 ft. At present (with a few isolated exceptions) the mines are all on their first lift, and the foregoing would no doubt be much modified by experience, particularly in the need of leaving thicker bands of coal between the lower lifts, and also narrower bords and stronger pillars; but there is no doubt that this method at its best will mean a low extraction, and a corresponding woeful waste of good coal. Taking the first example of 78 ft. total thickness, and assuming that by careful surveying each lift is safely worked, and assuming also that by successful pillar working a district extraction of, say, 60 % can be made, a further deduction of, say, 10 % should be allowed for the district or panel barriers, which must remain in until the final lift is being finished. This will reduce the total extraction to, say, 50 %; that would be 50 % of 50 ft., or only 25 ft. out of the total thickness of 78 ft. = 32 %—that is to say, one-third only of the total coal will be won, the remaining two-thirds being wasted or lost in process of extraction. This one-third extraction no doubt means a high tonnage per acre, for assuming, say, a total thickness of 60 ft. over 4 sq. miles or 2560 acres (a very conservative estimate), there is a total quantity of 260,268,457 tons, one-third of which would mean a saleable quantity of 86,756,152 tons. This 86¾ million tons will no doubt last a considerable time and provide good fuel for generations that will follow, but

the lamentable waste of the remaining 173½ million tons is a serious national loss, and it is our duty to safeguard such a national asset.

A modification of the foregoing method of working, and one to which the author has given considerable thought, would be to, as far as possible, entirely extract the whole of the coal when making the first lift in the topmost section, and let down the overburden uniformly on the coal floor before commencing the second lift. This should ensure a higher extraction in each lift section, and possibly allow a thinner band of coal to be left between each lift, thus providing for a considerably higher total extraction. Against this is the fact that the whole of the surface of the lands will be broken and will subside considerably, thus entailing the flooding of the mines during the wet seasons, to which the central district of Queensland is subjected, and also probably generating gob fires underground.

A much safer method would be hydraulic stowage or the infilling of worked areas in small districts by sand or other fine material conveyed underground in a fluid condition by piping, the water being drained out and pumped back to the surface to be used over again, leaving the infilling material tightly packed in the area from where the coal had been taken. By this method practically the whole of the seam could be extracted with very little subsidence of the surface. A big difficulty, however, presents itself in the fact that there is very little suitable material available on the surface, and no hills adjacent to the mines from which material could be quarried and ground to a suitable fineness. Moreover, if excavation and grinding had to be adopted to provide sluicing material, it is very questionable if the cost of stowage would not greatly exceed the coal-production costs and thus make the proposition unprofitable. A further method, and one that will doubtless appeal to the engineering instincts of members, is that of open-cutting, first stripping off the overburden with mechanical shovels and conveyers and then extracting the coal by the same process and tools, thus doing away with mining altogether. This method is, in the writer's opinion, quite

feasible, and, from the standpoint of conserving a national asset (which is the aspect he had in mind when contributing these remarks), is, he considers, the best method of dealing economically with the problem of the total extraction of this huge deposit. A considerable amount of capital would be required, as the initial outlay for suitable plant would be high, but it is not proposed to go into that phase of the question in this paper, which is merely intended to outline a method of total extraction. Assuming the owners are in a position to carry out this work, and assuming also that a market is available for the big output it will be possible to maintain, the writer is of opinion that the low production costs by quarrying as compared with mining will give a very good return on the capital invested.

The distance between Blair Athol and Rockhampton is 240 miles, with a further 38 miles to the deep sea at Port Alma, and the cost of freight has (and rightly) been considered an insuperable barrier to extensive shipping trade. To carry out the open-cutting scheme of extraction and to obtain the necessary increased output some other means of connecting the field with deep water must be found. This means a new direct railway to the coast. This latter can be achieved by building a direct line from Blair Athol to the deep-water port of Broadsound, a distance of approximately 130 miles, as compared with the present distance of 278 miles to Port Alma.

It is believed that the route does not present very great engineering difficulties, and that such a line could be built with moderate grades, for it is essential that to economically handle coal over such distances, as large train-loads as possible must be used. Owing to high grades on the present line the hauling capacity of the biggest locomotives is under 200 freight tons, and it should be easily possible to build a line to carry at least twice that quantity at each trip.

Taking the whole scheme into consideration, the first stripping of the overburden above the coal seam would be used to build the line with as uniform a grade as possible. The coal would then be quarried out and transported by conveyers to storage bins

erected at the railway line, from which the railway waggons could be filled quickly and despatched in train-loads as required. Stripping must necessarily precede the quarrying of the coal, and the debris would be deposited uniformly behind the coal face, forming a new surface-level.

In the foregoing remarks the author has endeavoured briefly to outline a problem of much national importance, and would welcome helpful criticism from members, for all will agree that it behoves engineers in this age to do their part to, as far as possible, conserve for future generations such a great national asset as is found in the Blair Athol coal deposit.

Queensland and New South Wales are no doubt extremely fortunate in possessing excellent coal-fields, but it must be borne in mind that the life of each field is limited to its available tonnage, and though it will, of course, be the aim of the colliery engineer to secure as high a percentage of extraction as possible, there will no doubt be instances known to members of wasteful mining methods in the past.

Wastage arises from many causes, and the author is prepared to admit that much of it is unavoidable, also that owners are beginning to realize the economy of employing better qualified men to lay out their mining operations than in the old "rip and tear" days; but the question arises, Can we not go still a little further, and, by pointing out the wisdom of looking beyond the period of our own individual term of mining work to the needs of those who are to follow, thus prevent in some degree the occurrence of avoidable waste?

In the author's opinion, owners of coal properties have in the past been too much inclined to adopt the short-sighted policy of giving every credit to the men whose sole object is to show low production costs, and the result in many cases has been wastage in the form of pillar-coal lost, or bands of workable coal left behind never to be recovered. It might be suggested that—"In the interests of National Economy," the Mines Departments should have power through their inspectors to provide that the system of mining adopted at each colliery was such that all

marketable coal was worked. At present these inspectors have the power to restrict mining operations in places that present danger, but they have no voice in the matter of preventing the high losses in pillar-drawing by improper methods in the first working of the seam, or of marketable coal bands being left in the pit.

It is for the colliery engineer to take the lead in this matter, and demonstrate again that the policy of obtaining the best advice in the matter of the laying-out of colliery workings means true economy both to the owner and the State.

PROCEEDINGS

OF THE

AUSTRALASIAN

Institute of Mining Engineers.

NEW SERIES.

No. 33.

EDITED BY THE SECRETARY.

This Institute is not responsible, as a body, for the facts and opinions advanced in any of its publications.

31st MARCH, 1919.

PUBLISHED QUARTERLY BY THE AUSTRALASIAN INSTITUTE OF MINING ENGINEERS, MELBOURNE.

Australasian Institute of Mining Engineers.

LIST OF OFFICERS, 1919.

President:

W. E. Wainwright, N.S.W.

Vice-Presidents:

D. B. Waters, N.Z. | R. W. Chapman, S.A.

George C. Klug, W.A.

Councillors:

A. A. Boyd	Queensland
James Hebbard	New South Wales
James Horsburgh	Queensland
F. Danvers Power	New South Wales
Lindesay C. Clark	Tasmania
H. H. Schlapp	Victoria
Robert C. Sticht	Tasmania
E. G. Banks	New Zealand
W. H. Corbould	Queensland
C. F. Courtney	New South Wales
H. Lipson Hancock	South Australia
H. Herman	Victoria
E. W. Skeats	Victoria
John W. Moule	Queensland
G. D. Delprat	New South Wales
Richard Hamilton	Western Australia
A. S. Kenyon	Victoria
Geo H. Broome	Victoria
George Weir	New South Wales
J. W. Sutherland	Western Australia
Colin Fraser	South Australia

Secretary:

D. L. Stirling, Melbourne, Vic.

Local Correspondents:

South Australia	Professor R. W. Chapman, Adelaide.
New South Wales	F. Danvers Power, Sydney.
Western Australia	F. W. R. Godden, Kalgoorlie.
New Zealand	D. B. Waters, Dunedin.
Tasmania	Russell M. Murray, Mount Lyell.
North Queensland	Murray Russell, Cloncurry.

Branch Secretaries:

Kalgoorlie	F. W. R. Godden, Ivanhoe Gold Corporation, Boulder, W.A.
Broken Hill	J. M. Bridge, c/o Zinc Corporation Ltd., Broken Hill, N.S.W.
Mount Morgan	B. G. Patterson, Mount Morgan, Q.

The Executive Committee consists of all Members of the Council residing, or for the time being, in Melbourne.

Head Office:

48 Queen Street, Melbourne, Victoria.

Institute Matters.

CONTENTS.

MINUTES OF MEETINGS—	Page
Of the Institute	
Annual Meeting—1919	iii
Report of Council—1918	iv
Balance Sheet	xii
Of the Council	xv
Of the Executive Committee	xv
NOTICES	xviii
PUBLICATIONS—Added to Library	xx
RECENT ARTICLES—On Mining Matters	xxiii
LIST OF MEMBERS—Names and Addresses	xxvii

MINUTES OF MEETINGS.

OF THE INSTITUTE.

ANNUAL MEETING.

MELBOURNE, 31ST JANUARY, 1919.

IN THE INSTITUTE ROOMS, 48 QUEEN STREET, AT 1 P.M.

Professor E. W. Skeats occupied the chair.

The Secretary read the notice convening the meeting.

Minutes of the First Ordinary Meeting, 1918, were confirmed.

The Report of the Council and Balance Sheet for 1918, were submitted and adopted.

As the nominations to fill the vacancies created by the annual retirement of office-bearers were not in excess of the vacancies the chairman declared the following elected :—

President	-	W. E. Wainwright, N.S.W.
Vice-President	-	George C. Klug, W.A.
Council	-	G. D. Delprat, N.S.W.
		R. Hamilton, W.A.
		A. S. Kenyon, Vic.
		G. H. Broome, Vic.
		George Weir, N.S.W.
		Colin Fraser, S.A.
		J. W. Sutherland, W.A.

The Meeting then closed.

Report of Council for 1918.

TO THE MEMBERS.

In submitting its report of the proceedings of the Institute for 1918, the Council, with the rest of the world, rejoices at the termination of the great world-war, and shares the pride which all Britishers feel in the glorious part the Nation has taken in that great and terrible struggle.

Membership now totals 585, made up as follows :—Honorary member, 1 ; life members, 5 ; members, 370 ; associate members, 149 ; students, 60. Nine members, four associate members, and one student were admitted during the year ; five members resigned, three died, and three were killed in action. The net gain, therefore, was three.

It is with regret that the Council has to record the deaths of three members :—Messrs. August Simson, of Launceston, Tas-

mania (foundation member); F. A. Marriott, of Bulawayo, South Africa; and O. B. Ward, late manager of Broken Hill Proprietary Block 10 mine, and of Misima, Papua.

Three student members were killed on active service—Norman Ford, R. Ingram Moore, and Virgil Tucker. Norman Ford (Lieut.) was formerly a student of the Charters Towers School of Mines, and later assayer with the Chillagoe Co. On the outbreak of war he went to German New Guinea as a member of the military force which captured that territory; he then went to Africa, obtaining a position on the Tarquah mines. Whilst in England on leave he enlisted, and gained his commission as Second Lieutenant in the Royal Engineers. After nine months at the Front he was transferred to the Flying Corps as observer. Virgil Tucker, prior to his enlistment, early in the war, was with the Zinc Corporation Ltd., Broken Hill. R. Ingram Moore (Capt.), D.S.O., was formerly attached to the Vegetable Creek Tin Mining Co., Emmaville, N.S.W. Their loss is mourned and their memory honoured.

Two meetings of the Institute were held during the year—the Annual Meeting in Melbourne on 21st January, and the First Ordinary Meeting at Newcastle, N.S.W., on 24th to 29th August. A full report of the First Ordinary Meeting appeared in No. 31 of Proceedings. The meeting was one of the best attended and most important yet held, and its success was mainly due to the splendid reception and treatment by the management of the important works visited. The Council desire to place on record their appreciation of courtesies extended by the following:—The Broken Hill Proprietary Co. Ltd., the Sulphide Corporation Ltd., State Government Dockyard, the management of the Caledonian Collieries Ltd., and Messrs. Morison and Bearby.

At the end of September the head office of the Institute was transferred to rooms at 48 Queen-street, Melbourne. These rooms are in the centre of the mining quarter of the city, and suitable for the home of a Mining Institute. In its new quarters the Institute is associated with the Australian Mines and Metals Association.

The following important recommendation from Members present at the Newcastle meeting was considered by the Council, viz. :—

"That it be a recommendation from this meeting to the Council to consider the advisability of altering the name of the Institute to that of the 'Australasian Institute of Mining and Metallurgy.'"

The Council decided that this recommendation be published in the Proceedings and a ballot taken on the question. Change of name has been discussed by the Council on several occasions during recent years. The section of metallurgy is each year becoming more important, and it is considered that this fact should be recognized in the title. Apart from this, many of our prominent Members follow occupations for which the title of "mining engineer" is not appropriate.

A number of valuable and informative papers were published in the Proceedings, and the Council hopes that, with the termination of the war, members will again be able to concentrate their thoughts and efforts on Institute affairs, contributing papers to assist in making the Proceedings of the Institute more and more valuable as a record of mining and metallurgical science and practice in Australasia.

Mr. L. Keith Ward, Director of Mines for South Australia, was appointed during the year as the Institute's representative on the Mining Bursaries Committee attached to the Adelaide University.

The Institute took part in a conference, convened by the Advisory Council of Science and Industry, and held in Melbourne on 12th December, to consider the question of the establishment of a local committee in Australia, to be in direct communication with the British Committee in London, and to act in an advisory capacity to it in drawing up standard engineering specifications for the Commonwealth. It was agreed that it was desirable to establish in Australia a representative authoritative body to take the matter of standardization in hand. Mr. C. F. Courtney is the representative of the Institute on the committee.

In accordance with a resolution passed at the Engineering Conference held in Sydney in May, the Prime Minister was advised that the Institute was willing to form an Honorary Advisory Committee to assist the Commonwealth Government in mining and metallurgical matters in connection with national organization arising out of the war.

The work done by Dr. Stillwell at Bendigo on the localization of gold shoots, and the fact that his term of engagement was nearing completion while much still remained to be done, caused the Council to adopt the following resolution :—

"That the Council of the Australasian Institute of Mining Engineers recognizes the value and importance of the work on the localization of gold shoots now being carried out by Dr. Stillwell in the Bendigo district, is hopeful that the results obtained and to be obtained will be found applicable to other gold quartz-mining fields in Australia, and hopes that the Advisory Council of Science and Industry will be able to arrange for the continuance of this work, and thereby continue to give practical assistance to an industry working at present under adverse economic conditions."

It is satisfactory to be able to report that, as a result of the recommendation, this work is being continued for another year, mining companies of the districts contributing half the cost.

During the year instances of several members who had qualified for commissioned rank in the A.I.F., but who were being shipped abroad as sappers, were brought before the Council, and their special claims submitted to the authorities.

Early in the year £400 worth of inscribed stock was purchased in the Commonwealth War Loan, making the total on that account £1000. The balance sheet shows the financial position to be satisfactory.

The Institute is again indebted to Mr. A. T. Danks, of Melbourne, for the gift of £10 for the best paper contributed by a student taking part in the visits of inspection in connection with the Newcastle meeting.

The Council has been advised by the Federal Attorney-General that the constitutional powers of the Commonwealth were too

limited to permit of satisfactory legislation upon the subject of incorporation of companies, and that he was not prepared to consider the question of legislation to provide for incorporation of the Australasian Institute of Mining Engineers in advance of general company legislation.

Members were advised in the Annual Report of the Council for 1917 of the proposal to federate or amalgamate the various Australian Engineering Institutes and Associations. The proposal originated in a long-standing desire on the part of engineers, other than mining engineers, to amalgamate the various small existing associations and form one strong Australian Institution of Engineers, such as was done when the mining engineers formed the Australasian Institute of Mining Engineers. This proposal received the sympathy and support of the latter body, whose suggestion was that, in the event of the formation of an Australian Institute of Engineers, to federate with that body. The history of the movement is reported in Proceedings No. 31, and has, no doubt, been read by all members. At the commencement of the present movement the Council expressed itself in favour of "federation" of Institutes, and passed the following resolution :—

"That the Council of the Australasian Institute of Mining Engineers is desirous of assisting other engineering Associations in every way to become a corporate body in matters Federal, but is opposed to such Institute being composed of individual members, and strongly recommends delegates to endeavour to induce other representatives to agree to a Federal Institute representing the various engineering Institutes of Australia."

It was on this understanding, and with the hope that federation would eventuate, that the Institute took part in the proceedings. Messrs. H. H. Schlapp, G. C. Klug, and A. S. Kenyon were appointed representatives of the Australasian Institute of Mining Engineers. At the conference held in Melbourne in February a provisional Council was appointed. The provisional Council met in Sydney in May, and, as Messrs. Schlapp, Klug, and Kenyon

were unable to attend, Messrs. F. Danvers Power and Wm. Poole were appointed substitutes for the Sydney meeting.

The provisional Council, after deciding the main points of the proposed constitution, appointed a sub-committee to put the constitution into proper form. Messrs. Power and Poole were authorized to act on that drafting committee. A draft constitution was subsequently issued, but, as it contained no provision for "federation," your Council could not recommend its acceptance. Shortly after the issue of the first draft constitution the First Ordinary Meeting was held at Newcastle, when the Executive Committee reported the position to members there assembled. The general feeling of members present was against "amalgamation," but in favour of some form of "federation." No encouragement or support being given to this Institute's request for federation, the Executive Committee considered it unwise to be further represented on a sub-committee drafting a scheme of "amalgamation." Messrs. Poole and Power were thanked for their services, and requested to withdraw from that committee.

A second revised draft-constitution has recently been issued, but no provision for "federation" is included. On the advice of its representatives the Executive Committee has decided that it cannot recommend its acceptance by members of the Australasian Institute of Mining Engineers.

It is understood that a final proposed constitution will shortly be issued, when, as recommended by members at the Newcastle meeting, copies will be forwarded to members, who will be asked to vote on the question of the Australasian Institute of Mining Engineers joining in the proposed amalgamation scheme. The Executive Committee of your Council has strongly recommended the rejection of the constitution as proposed, for reasons fully outlined in Proceedings No. 31, pp. xliv–xlvii.

The Roll of Honor accompanying this report (pp. x, xi) contains the names of those members known to have enlisted during the war. This great response for the Nation's sake is a matter of very great pride.

HONOR ROLL.

The Council will be pleased to receive information regarding any further names of members of the Institute who served during the war in the Armies or Navies of the Allied Nations. Information would also be appreciated regarding any distinctions that may have been conferred on any member, or any changes that may have taken place in rank, etc.

Aarons, J. Boyd
Adcock, Garnet I.
Alexander, Hubert
Anderson, E. S.
Anderson, W. T.
Avery, Wm. P.
Bayly, Colin (Killed in Action)
Banks, C. A.
Barber, C. S.
Bennet, V. C.
Berriman, R. V.
Best, G. H. T. (Military Cross)
Bell, W. G. (Killed in Action)
Bell, J. Mackintosh
Bloom, Leo
Blunden, L. E.
Bray, F. P.
Brown, H. Wheeler
Bullen, G. L.
Burbidge, Percy
Campbell, A. G.
Casey, R. G. (D.S.O.)
Carless, Noel
Carroll, H. H.
Connor, J. L. (Killed in Action)
Coulter, Leslie J. (D.S.O.) (Killed in Action)
Cowles, Richard
Clayton, C. H. T.
Cleland, W. L.
Davies, H. Warlow
Dempster, G. C.
Donaldson, R. J. (D.S.O.)
Dow, J.
Drain, P. J.
Dubois, A. J.
Dunstan, Basil
Eastaugh, F. A.
Elford, C.
Ford, Norman (Killed in Action)
Foster, Donald
Foxall, J. S.
Fraser, E. H.
Fraser, D. L.
Finlayson, R. J. Stanley
Gartrell, W. H.
Gabriel, G. E. (Military Medal)
Grieve, W. H.
Goode, K. B.
Grut, L. de Jersey (Military Cross)
Hargraves, E. L.
Hammel, H. E.
Herbertson, R. C. (Killed in Action)
Hogarth, A. M. (Killed in Action)
Holder, E. M.
Hooper, F. H.
Horsley, Ralf D.
Hunter, Stanley B.

Hughes, Eric W.
Irvine, C. L.
Jowett, A. C.
Kelly, A. H.
Kelly, M. B. H
Kerr, F. T.
Key, J. F.
Kneebone, C. S.
Lakeland, Wm. J.
Lewis, Keith B.
Marks, D. G.
Mawdsley, W. H.
Marryatt, Cyril B.
MacDonnell, W. H. A.
MacKenzie, D. C.
M'Bryde, Jas. (Killed in Action)
Mickle, Kenneth A. (D.S.O.)
Millett, Bert
Moore, R. Ingram (D.S.O.) (Killed in Action)
Morris, A. C.
Mulligan, E. N.
Moore, K. Byron
M'Callum, N. S. Kellie
M'Padden, J. C.
Nicholas, F. H. (Military Medal)
Newman, J. Malcolm
Osborne, G. W.
Pearson, H. F.
Peat, James (Killed in Action)
Peberdy, J. R.
Pethebridge, H. S.
Plant, G. H. D.
Rabling, Harold
Roberts, W. J.
Rose, W. J. (Military Cross)
Ross, C. N.
Rutherford, A. R.
Rutherford, T. W. L.
Rae, Cecil
Sayer, W. T. (Killed in Action)
Seale, H. V.
Shaw, J. B.
Skerritt, A. W.
Smith, H. Hardy
Smith, R. S.
Smith, W. F.
Smith, E.
Southon, R. D.
Sweet, O. G.
Tandy, A. E.
Taylor, A. S.
Taylor, E. Foulkes
Townsend, H.
Tucker, V.
Turner, W. A.
Twine, G. J.
Veitch, Neil A.
Wallmann, H. P.
Warde, Harvey S.
Waters, Professor D. B. (Vice-President)
Watts, R. T. (Killed in Action)
Wentworth, D'Arcy
Weigall, H. S.
Williams, O. B.
Wilkins, Lawrence G.
Woodward, O. H. (Military Cross)

AUSTRALASIAN INSTITUTE OF MINING ENGINEERS.

Balance Sheet, 31st December, 1918.

LIABILITIES.				ASSETS.					
Subscriptions paid in advance		£21 11 6		State Savings Bank at Credit	£300 0 0				
Sundry Creditors		111 0 0		Commonwealth Savings Bank at Credit	83 3 11		£383 3 11		
A. T. Danks—Student's Prize unexpended		10 0 0		Commonwealth of Australia War Loan	1000 0 0				
Accumulated Fund—				Commonwealth of Australia War Savings Certificates, (at face value)	64 10 0		1064 10 0		
Balance at 31st Dec., 1917	£1311 17 2			Outstanding Subscriptions, 1918			112 2 0		
Add Surplus transferred from Revenue A/c ...	131 10 8			Sundry Debtors for Advertisements			5 0 0		
		1443 7 10		Office Furniture, Melbourne and Broken Hill Branch ...	25 7 11				
				Less Depreciation	4 4 6		21 3 5		
		£1585 19 4					£1585 19 4		

Melbourne, 31st January, 1919. Audited and found correct. Oxlade & Mackie, Auditors.

RECEIPTS.

Dec. 31st, 1918.						
To Commonwealth Savings Bank at Credit ...	£350	0	0			
State Savings Bank at Credit	154	11	3			
Dec. 31st, 1918.				£504	11	3
Members' Subs., 1914 ...	2	2	0			
,, ,, 1915 ...	4	4	0			
,, ,, 1916 ...	16	6	0			
,, ,, 1917 ...	77	9	0			
,, ,, 1918 ...	610	12	4			
,, ,, 1919 ...	19	9	6			
,, ,, 1920 ...	2	2	0			
				732	4	10
Advertisements ...	41	10	0			
Sales	19	5	9			
Entrance Fees	16	5	6			
Meeting Expenses Refund	14	16	6			
Savings Bank Interest	52	13	6			
A. T. Danks—Student's Prize	10	0	0			
				154	11	3
				£1391	7	4

EXPENDITURE.

By Printing & Stationery ...	£9	14	0			
Rent	44	6	8			
Salaries	255	13	4			
Postages, Telegrams, &c.	27	7	1			
Sundries	55	5	2			
Proceedings	115	10	2			
Commission	6	4	6			
Meeting Expenses ...	45	0	0			
Commonwealth of Australia War Loan ...	400	0	0			
Commonwealth of Australia War Saving Certificates (Face Value)	49	2	6			
				1008	3	5
Commonwealth Savings Bank at Credit ...	83	3	11			
State Savings Bank at Credit	300	0	0			
				383	3	11
				£1391	7	4

Revenue Account for the Year ended 31st December, 1918.

1918.							1918.						
Dec. 31.	To Publications	£226	10	2			Dec. 31.	By Subs., 1914 ...	£2	2	0		
	Stationery & Printing ...	9	14	0				,, 1915 ...	4	4	0		
	Meeting Expenses ...	30	3	6				,, 1918 ...	725	6	10		
	Postages, Telegrams, &c....	27	7	1								731	12 10
	Salaries ...	255	13	4				Advertisements and Sales ...				46	15 9
	Rent ...	44	6	8				Entrance Fees				16	5 6
	Sundries ...	55	5	2				Interest				52	13 6
	Commission	6	4	6									
					£655	4 5							
	Bad Subscriptions written off ...	56	8	0									
	Depreciation on Furniture	4	4	6									
					60	12 6							
	Balance transferred to Accumulated Fund ...				131	10 8							
					£847	7 7						£847	7 7

Melbourne, 10*th January*, 1918. Audited and found correct. Oxlade & Mackie, *Auditors.*

Of the Council.

February 24th, 1919—1 p.m.

Resolved that an Executive Committee consisting of all members of the Council resident or, for the time, being in Melbourne be appointed for 1919.

Of the Executive Committee.

(Summary)

January 6th, 1919—1 p.m. (Special Meeting).

Circular letter issued to members of Council by Messrs. F. Danvers Power and William Poole on the subject of the proposed amalgamation of Engineering Associations was submitted, and it was resolved that members of Council be requested to refrain from replying thereto until the matter had reached the stage at which the Executive Committee could place it officially before them.

It was further resolved that Messrs. Power and Poole be informed that before the Executive Committee could discuss the later proposed constitution it had to await the report of its representatives on the Provisional Council—Messrs. Schlapp, Klug, and Kenyon—who had intimated that up to the present they had not received copies of the constitution from the Secretary of the Provisional Council.

January 17th, 1919—1 p.m.

The Secretary's Report was presented, and accounts to the amount of £56 passed for payment.

Nominations of Messrs. T. W. Wellsted and Thomas Sampson as Associate Members were approved.

Resignations of Mr. Joseph Grimmond on account of advanced age and of Mr. M. Henry Carbin on account of sickness were accepted with regret.

The death of Mr. H. R. Hancock (Foundation Member) was reported, and a letter of sympathy directed to be forwarded to the family of the deceased Member.

Mr. C. F. Courtney was appointed to represent the Institute on a Committee, to be appointed, to deal with the question of engineering standardization in Australia.

The report of the Institute's representatives on the Provisional Council (Messrs. H. H. Schlapp, G. C. Klug and A. S. Kenyon) on the latest revised constitution of the proposed Institution of Engineers of Australia was presented and adopted. Resolved that the Secretary of the Provisional Council be informed that as the constitution contains no provision for "Federation" in lieu of "Amalgamation" the Executive Committee of the Australasian Institute of Mining Engineers cannot at this stage recommend its acceptance. It was further resolved that a memorandum on the position be prepared and issued to all members of the Council; the memorandum to include the report of the Institute's representatives on the Provisional Council. Directions were given regarding replies to other correspondence on the subject.

Other routine business was transacted.

JANUARY 21ST, 1919—1 P.M.

Draft of memorandum for members of Council in reply to circular letter issued by Messrs. F. Danvers Power and William Poole was submitted and, after revision, approved.

JANUARY 24TH, 1919—1 P.M. (SPECIAL MEETING).

The draft of the Annual Report of the Council for 1918 was submitted and, with a few slight alterations, was approved.

FEBRUARY 24TH, 1919—1.15 P.M.

The Secretary's Report was submitted, and accounts to the amount of £75 passed for payment.

Finance, Publication and Education, and Branches Committees were appointed for 1919.

It was reported that Mr. W. G. Bell (Life Member) had been killed in action at the front, and a letter of sympathy was directed to be forwarded to the relatives of the deceased.

Appreciation was expressed at Mr. J. W. Sutherland's donation of 50 guineas for the encouragement of students in mining engineering, and the Publication and Education Committee was requested to draw up a scheme to carry out Mr. Sutherland's wishes.

Correspondence on the subject of amalgamation was submitted and directions given regarding replies thereto.

Consideration was given to the question of the locality of the First Ordinary Meeting. 1919. The fixing of the time and place of meeting was deferred pending further enquiries.

It was reported that Mr. Theodore W. Tobe had been awarded the "A. T. Danks' Prize." 1918.

Other routine business was transacted.

March 13th, 1919—5 p.m. (Special Meeting).

It was unanimously resolved that the action of Messrs. Schlapp, Klug and Kenyon, the Institute's representatives on the Provisional Council of the proposed Institution of Engineers of Australia, be endorsed.

It was further resolved that a Committee be appointed to draft a circular to members in reply to letters published in the technical press by Messrs. Power and Poole.

NOTICES.

The rooms of the Institute are open from 9 A.M. to 5 P.M. daily, except Sundays and Public Holidays.

MEMBERSHIP.

Applications for admission to the Institute as Associate Members have been received from the following:—Thomas Sampson, "Montana," High-street, Sheffield, Tas. and Thomas William Wellsted, Collins House, Collins-street, Melbourne, Vic. These names are now submitted to members for confidential report.

MOVEMENTS OF MEMBERS.

V. C. Bennett who recently returned from active service at the front is now with the Electrolytic Zinc Company of Australia Ltd., at Collins House, Collins-street, Melbourne.

J. Murdoch Eaton is with the Royalist Mining Co., at Que Que, Southern Rhodesia.

W. G. B. Boydell of the Seoul Mining Co., Hol Kol Mine, Whang Hai Province, Korea, visited Melbourne in March on furlough.

E. P. Hargraves sailed for Singapore in March under engagement by a tin mining company.

G. D. Delprat, General Manager of the Broken Hill Proprietary Co. Ltd., is now on a visit to America and Europe.

Louis N. Stutterd, after being five years in the Northern Territory, is in Melbourne on furlough; he is Manager of the Government battery at Marranboy, N.T.

Robert Slessor of Sydney is leaving for China in May.

J. V. W. Mathers of the Mararoa G.M. Co. is now at the Light of Asia Mine, Que, W.A.

OBITUARY.

H. R. Hancock, Foundation member of the Institute, died on 15th January, 1919. He was born in Devon, England, in 1836, and came to Australia in the year 1859 under engagement from the Wheal Ellen Copper Co. He assumed control of the Moonta Mine when 28 years of age. For 22 years he superintended

operations at the Moonta and Wallaroo Mines, and retired in 1898. Captain Hancock took a keen interest in technical education and assisted in establishing the Moonta School of Mines. His work in connection with philanthrophic and religious institutions and his concern for the welfare of employees gained for him the esteem of everyone. He was the inventor of the Hancock jig and the Hancock rock drill. Apart from his great work in connection with mining, he took a keen interest in agriculture. Mr. H. Lipson Hancock, General Manager of the Wallaroo and Moonta Mining and Smelting Co. Ltd. is the late Captain Hancock's eldest son.

Rossiter Worthington Raymond, Ph.D., LL.D., honorary member, died suddenly from heart failure at his home, 123 Henry-street, Brooklyn, N.Y., on December 31st, 1918. He was Secretary Emeritus of the American Institute of Mining Engineers and was its guiding spirit for 47 years. On account of his valuable advice and assistance to the Australasian Institute of Mining Engineers during its reorganization, Dr. Raymond was made an honorary member.

Killed in Action.

Francis P. Bray (member) was killed in action, in France, on 23rd November, 1918. Mr. Bray joined the Royal Engineers at the commencement of the war. He was the second son of John M. Bray, of Middle Park, Victoria, and was 43 years of age. Prior to the war, he was for a number of years engaged in mining operations in West Africa.

W. H. A. MacDonell (student) has been reported killed in action in France in August, 1918. He was a student of the Charters Towers (Queensland) School of Mines.

LIST OF PUBLICATIONS ADDED TO THE LIBRARY

From 31st December, 1918 to 31st March, 1919.

Australian Mining and Engineering Review	monthly	Melbourne
Engineering and Mining Journal	weekly	New York
Iron and Coal Trades Review	weekly	London
The Colliery Engineer	monthly	Scranton, Pa.
Mining and Engineering World	weekly	Chicago
Mining Magazine	monthly	London
Indian Engineering	weekly	Calcutta
Chemical News	weekly	London
South African Engineering	monthly	London
Journal of Industrial and Engineering Chemistry	monthly	Easton, Pa.
Society of Chemical Industry : Journal	bi-monthly	London
Chemical, Metallurgical and Mining Society of South Africa : Journal	monthly	Johannesburg
Franklin Institute : Journal	bi-monthly	Philadelphia
Institution of Mechanical Engineers : Journal	monthly	London
Metallurgical and Chemical Engineering	monthly	New York
Chamber of Mines of Western Australia : Journal	monthly	Kalgoorlie
The West Australian Mining, Building and Engineering Journal	weekly	Perth
Queensland Department of Mines : Government Mining Journal	monthly	Brisbane
Transvaal Chamber of Mines : Monthly Analysis of Production		Johannesburg
Rhodesia Chamber of Mines : Report of Executive	monthly	Bulawayo
Royal Society of Victoria : Proceedings, Vol. XXXI., Part 1		Melbourne
New South Wales Board of Trade : Interim Report on Miners' Phthisis and Pneumoconiosis in Certain Industries, Vols. I. and II.		Sydney
Royal Society of Queensland : Proceedings, Vol. XXX.		Brisbane

University of Adelaide :
Calendar, 1919 - - - - Adelaide
Royal Society of South Australia :
Transactions and Proceedings, Vol. XLII. - Adelaide
Department of Mines, Tasmania :
Geological Survey, Bulletin, No. 28 - - Hobart
New Zealand Journal of Science and Technology :
Vol. I., No. 6, Vol. II., No. 1
Papers :—
Notes on the Geology of the Waikato Valley near Maungatautari, by J. Henderson
Notes on the Geology and Mineral Occurrences of the Wakamarina Valley, by J. Henderson
The Geology of the Te Kuiti District, with special reference to Coal Prospects, by J. Henderson
Notes on the Geology of the Murchison District, by J. Henderson
Notes on the Geology of the Cheviot District, by J. Henderson
Commercial Uses of New Zealand Minerals (chiefly non-metallic) and Rocks, by P. G. Morgan - - - - Wellington
Geological Society :
Quarterly Journal, No. 291 - - - London
Institution of Mining and Metallurgy :
Bulletins, Nos. 168-172 - - - London
Institution of Mining Engineers :
Transactions, Vol. LVI., Parts 1 and 2 - London
Société des Ingenieurs Civils de France :
Bulletin, October, 1918 - - - Paris
Annales des Mines :
Vol. VII., Pages 81-261 - - - Paris
Geological Survey of India :
Records, Vol. XLIX., Parts 2 and 3 - - Calcutta
Department of Mines, Canada :
Geological Survey—Summary Report, 1917, Parts C and E - - - - - Ottawa
American Institute of Mining Engineers :
Bulletins, Nos. 144-146 - - New York

California State Mining Bureau :	
Bulletin, No. 83	
Preliminary Report, No. 4—Tungsten, Molybdenum and Vanadium	
Preliminary Report, No. 5—Antimony, Graphite, Nickel, Potash, Strontium, Tin - -	Sacramento
Smithsonean Institution :	
Annual Report, 1916 - - -	Washington
Nova Scotian Institute of Science :	
Proceedings and Transactions, Vol. XIV., Part 3	Halifax
Institution of Chemistry of Great Britain and Ireland :	
Proceedings, 1918, Part IV. - -	London

RECENT ARTICLES ON MINING MATTERS.

(31st December, 1918, to 31st March, 1919).

NOTE.—*This list is prepared for the purpose of placing before members the titles of the more important papers appearing in the usual publications concerned with mining engineering, metallurgy, &c., due regard being had to Australasian requirements.*

LIST OF PUBLICATIONS.

References are given by the number prefixed to each publication in the attached list. Wk., weekly; mth., monthly.

(1) *The Australian Mining Standard*, Melbourne, Victoria, wk., 6d.

(2) *The Queensland Government Mining Journal*, Brisbane, mth., 6d.

(3) *Metallurgical and Chemical Engineering*, New York, mth., 25c.

(4) *The Mining Journal*, London, E.C., wk., 6d.

(5) *Mining and Engineering World*, Chicago, wk., 10c.

(6) *The Engineering and Mining Journal*, New York, wk., 15c.

(7) *The Colliery Engineer*, Scranton, Pa., U.S.A., mth., 20c.

(8) *Mining and Scientific Press*, San Francisco, Cal., wk., 10c.

(9) *Annales des Mines*, Paris, France, mth.

(10) *Publications*, Department of Mines, Melbourne, Victoria.

(11) *Publications*, Department of Mines, Sydney, New South Wales.

(12) *Publications*, Department of Mines, Adelaide, South Australia.

(13) *Publications*, Department of Mines, Brisbane, Queensland.

(14) *Publications*, Department of Mines, Perth, Western Australia.

(15) *Publications*, Department of Mines, Hobart, Tasmania.

(16) *Publications*, Geological Survey, Canada, Ottawa, Ontario.

(17) *Publications*, Bureau of Mines, Toronto, Ontario.

(18) *Publications*, Geological Survey of India, Calcutta.

(19) *Publications*, Geological Survey, U.S.A., Washington.

(20) *Publications*, Geological Survey, Alabama, Montgomery, Ala.

(21) *Publications*, California State Mining Bureau, Sacramento, Cal.

(22) *Reports* Aust. Assoc. Adv. Science, Sydney, New South Wales.

(23) *Transactions and Proceedings*, New Zealand Inst., Wellington, New Zealand.

(24) *Quarterly Journal*, Geological Society, London.

(25) *Transactions*, Inst. Mining and Metallurgy, London, E.C.

(26) *Transactions*, Inst. Min. Eng., London.

(27) *Journal*, Canadian Mining Inst., Ottawa, Ontario.

(28) *Journal*, Chem., Min., and Met. Soc. of S.A., Johannesburg, Transvaal.

(29) *Transactions*, Am. Inst. of Min. Eng., New York City.

(30) *Proceedings*, Colorado Scientific Soc., Denver, Col.

(31) *Journal*, Franklin Inst., Philadelphia, Pa.

(32) *Australian Mining and Engineering Review*, Melbourne, Vic., mth., 6d.

(33) *Transactions*, Am. Soc. C.E., New York City.

(34) *Bulletins*, Société des Ingénieurs Civils, Paris.

(35) *Mining Magazine*, 819 Salisbury House, London, E.C., mth., 1s.

(36) *Publications*, Iron and Steel Institute, London.

(37) *Proceedings*, Inst. of Mech. Eng., London.

(38) *Publications*, Field Columbian Museum, Chicago, U.S.A.

(39) *Journal*, Mining Society of Nova Scotia, Halifax, N.S.

(40) *Transactions*, Mining and Geological Institute of India, Calcutta.

(41) *Publications*, Department of Mines, Wellington, N.Z.

(42) *Journal*, Chamber of Mines of West Australia, Perth.

(43) *Journal of Industrial and Engineering Chemistry*, Easton, Pa.

(44) *Proceedings*, Geologists' Association, London.

LIST OF ARTICLES.

MECHANICAL.

The Economy of Cork Inserts. (6) Nov. 9, 1918.
Effective Tube-Mill Liners. A. W. Allen. (6) Nov. 16, 1918.
United Eastern Mine Cage and Skip. B. C. Staiger. (6) Nov. 16, 1918.
Safety Base for Ladders. W. H. Macmahon. (6) Nov. 16, 1918.
Armstrong Mechanical Shovel. (6) Nov. 30, 1918.
The Lilly Hoist-Controller. (6) Nov. 30, 1918.
Improved Design of Chute Gate. W. L. Pronty. (6) Feb. 22, 1919.
Cooling of Electric Motors. P. A. Mossay. (26) Vol. LVI., Part 2.

METALLURGICAL.

Roaster Charger Belt Feeder. C. T. Rice. (6) Nov. 9, 1918.
Capacity of Belt Magnetic Separators. G. J. Young. (6) Nov. 16, 1918.
Hazards and Safeguards in Ore-Dressing Plants. J. S. M'Kaig. (6) Nov. 23, 1918.
Oliver Filter Modifications. C. T. Rice. (6) Nov. 23, 1918.
The Hewitt Pulp Distributor. (6) Nov. 23, 1918.
Dry-Concentration Plant in Arkansas. T. Shiras. (6) Nov. 23, 1918.
Sorting Ore for Metallurgical Treatment. A. W. Allen. (6) Nov. 30, 1918.
Ideal Dry Concentrator. (6) Nov. 30, 1918.
The Determination of Tin in High-Grade Wolfram Ores. A. R. Powell. (6) Nov. 30, 1918.
Electro-Cyanidation of Gold and Silver Ores. R. T. Sill and H. A. Sill. (6) Dec. 7, 1918.
Zinc-Box Practice. A. W. Allen. (6) Dec. 14, 1918.
Feeding Flotation Oil in the Cœur d'Alenes. C. T. Rice. (6) Dec. 14, 1918.
Free Acid Determination in Presence of Metallic Salts. L. F. Clark. (6) Dec. 21, 1918.
The Berdan Pan for Amalgamation. A. W. Allen. (6) Dec. 21, 1918.
Panning as a Guide to Sampling. (6) Dec. 21, 1918.
Importance of Particle-Size Reduction Before Sampling for Assay. A. W. Allen. (6) Dec. 28, 1918.
The Elimination of Gelatinous Silica in the Hydrometallurgy of Zinc. (6) Dec. 28, 1918.
Why Minerals Float. G. J. Young. (6) Dec. 28, 1918.
The Fluid Ton. A. W. Allen. (6) Jan. 4, 1919.
Metallurgy of Zinc. W. R. Ingalls. (6) Jan. 11, 1919.
Metallurgy of Lead. H. O. Hofman. (6) Jan. 11, 1919.
Metallurgy of Copper. A. L. Walker. (6) Jan. 11, 1919.
Metallurgy of Gold and Silver. A. W. Allen. (6) Jan. 11, 1919.
The Flotation Process. A. W. Allen. (6) Jan. 11, 1919.
Notes on Ore-Dressing. A. W. Allen. (6) Jan. 11, 1919.
Pulp Level Control. C. T. Rice. (6) Feb. 22, 1919.
Electrostatic Precipitation. R. B. Rathbon. (29) Bull. No. 29.
Fine Crushing in Ball Mills. E. W. Davis. (29) Bull. No. 146.
Volatilization of Cuprous Chloride on Melting Copper Containing Chlorine. S. Skowronski and K. W. M'Comas. (29) Bull. No. 146.
First Year of Leaching by the New Cornelia Copper Co. H. A. Tobelmann and James A. Potter. (29) Bull. No. 146.
Refining Gold Bullion with Chlorine Gas and Air. R. R. Kahan. (25) Bull. No. 170.
Effect of Heating and Heating and Quenching Cornish Tin Ores Before Crushing. A. Yates. (25) Bull. No. 170.
Development of Galena Flotation at the Central Mine, Broken Hill. R. J. Harvey. (25) Bull. No. 170.
Concentration of Lead-Zinc-Silver Ore at the Zinc Corporation's Mine. G. C. Klug. (35) Nov., 1918.
Treatment of Accumulated Tailing as Practised by the Zinc Corporation. G. C. Klug. (35) Dec., 1918.
Chloridizing-Roasting of Burnt Pyrites on the Rainer-Beskow System. P. Klason. (35) Dec., 1918.
Concentration at the British Broken Hill. G. C. Klug. (35) Jan., 1919.

MINING.

Standardization of Mining Methods : I.—Standard Raises. C. A. Mitke. (6) Serial commenced Nov. 6, 1918.
Re-opening the Golden Eagle Shaft. F. D. Bradley. (6) Nov. 16, 1918.
Standardization of Mining Methods : II.—Standard Machine-Drill Rounds. C. A. Mitke. (6) Nov. 16, 1918.
The Porphyry Coppers : Mining Methods. L. H. Goodwin. (6) Nov. 16, 1918.
Controlling the Drawing-off in Caving Stopes. (6) Nov. 23, 1918.
The Porphyry Coppers : Mine and Equipment Investment. L. H. Goodwin. (6) Nov. 23, 1918.
Standardization of Mining Methods : III.—Ventilation of Metal Mines. C. A. Mitke. (6) Nov. 30, 1918.
Standardization of Mining Methods : IV.—Explosives. C. A. Mitke. (6) Dec. 7, 1918.
Driving and Timbering Transfer Chutes. C. T. Rice. (6) Dec. 7, 1918.
Standardization of Mining Methods : V.—Fire Protection for Metal Mines. C. A. Mitke. (6) Dec. 14, 1918.
Standardization of Mining Equipment : VI.—Standard Equipment. C. A. Mitke. (6) Dec. 21, 1918.
Method of Re-lining Timber Sets. (6) Dec. 21, 1918.
Standardization of Mining Methods : VII.—Prospecting and Development. C. A. Mitke. (6) Dec. 28, 1918.
A Concrete Water-Seal Ring for Shaft. G. G. Wald. (6) Dec. 28, 1918.
Inclined Shaft Timbering and a Method of Alignment. A. Neustaedter. (6) Feb. 22, 1919.
Mining Methods of United Verde Extension Mining Co. C. A. Mitke. (29) Bull. No. 145.
Anthracite Mining Costs. R. V. Norris. (29) Bull. No. 146.
Study of Shovelling as Applied to Mining. G. T. Harley. (29) Bull. No. 146.
Training Students in Coal Mining. F. W. Hardwick. (26) Vol. LVI., Part 2.

MISCELLANEOUS.

Silver Spur Mine : Recent Development and Future Prospecting. Lionel C. E. Ball. (13) Publication No. 264.
The North Pieman and Huskisson and Sterling Valley Mining Fields. A. M'Intosh Reid. (15) Bull. No. 28.
Co-operation Among Small Mines. G. J. Young. (6) Nov. 9, 1918.
"Sengite," a New Explosive. J. P. Udal. (6) Nov. 9, 1918.
Tin in Nigeria. (6) Nov. 9, 1918.
The Gold Question. (6) Nov. 9, 1918.
The Tin Control. (6) Nov. 9, 1918.
Co-operation in Mine Promotion and Management. Paul T. Bruhl. (6) Nov. 16, 1918.
Mineral Industry in Burma. (6) Nov. 16, 1918.
The Gold Question. (6) Nov. 23, 1918.
Tin Dredging in Burma. (6) Nov. 23, 1918.
Utilization of Mine-Accident Reports. D. E. Charlton. (6) Nov. 30, 1918.
Wages, Working Costs, and Ore Reserves of the Rand. A. Cooper Key. (6) Nov. 30, 1918.
The Gold Question. (6) Nov. 30, 1918.
A Neglected Course in Mining Schools. (6) Nov. 30, 1918.
Safeguarding the Mine Shaft. D. E. Charlton. (6) Dec. 21, 1918.
Dust Abstraction in Mines. (6) Dec. 21, 1918.
Impressions of Australia and the Australians. G. C. Stone. (6) Jan. 4, 1919.
Australasia in 1918. W. P. Geary. (6) Jan. 11, 1919.
The Burma Mines Ltd. A. B. Parsons. (6) Feb. 8, 1919.
Examining and Developing the Mine Prospect. H. T. Curran. (6) Feb. 22, 1919.
A Symposium on the Conservation of Tin. (29) Bull. No. 144.
The Use of Coal in Pulverized Form. L. V. Adamson. (29) Bull. No. 144.
The Metallography of Tungsten. Z. Jeffries. (29) Bull. No. 144.
Two Instances of Mobility of Gold in Solid State. E. Keller. (29) Bull. No. 145.
Some Economic Considerations in Coke-Oven Practice. W. Colquhoun. (26) Vol. LVI., Part 2.
The Economy of Briquetting Small Coal. J. A. Yeadon. (23) Vol. LVI., Part 1.
Production of Power-Gas from Wood. L. B. Williams. (35) Nov., 1918.
The Gold Problem. H. Strakosch. (35) Nov., 1918.

GUIDE TO CONTRIBUTORS OF PAPERS.

It is requested that writing be confined to *one* side of the paper ; that it be legible with particular care regarding foreign words; and that abbreviations, references, &c . be made in accordance with the subjoined rules and examples:—

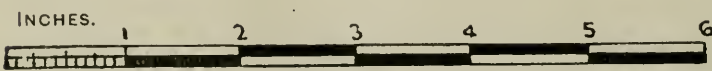
Pounds, shillings, and pence, £ s. d. ; dollars and cents, $, c.
Grains, gr., pennyweights, dwt. ; ounces, oz. ; drachms, dr. ; pounds, lb.
Quarters, qr. ; hundredweights, cwt.; gallons, gal.
Grammes, grm. ; kilogrammes, kg. ; millimetres, mm.; milligrammes, mg.
Centimetres, cm. ; cubic centimetres, cc. ; metres, m.
Inches, in. ; feet, ft. ; yards, yd.: fathoms, fath.
Square inches, etc , sq. in. ; cubic inches, etc., cub. in.
Diameter, diam.; revolutions, rev.; revolutions per minute, r.p.m.
Horse power, h p.; indicated horse power, i.h.p.; brake horse power, b.h.p.
Candle power, c.p.
British thermal units, B.Th.U.
High pressure, H.P. ; low pressure, L.P.
Ampere, amp.; kilowatts, kw.
Percentages, %; degrees, ° ; specific gravity, sp. gr.
Company Limited, Co. Ltd.; and Company, & Co.
Temperatures to be given in Fahrenheit, thus : 10° Fahr.
Figures not exceeding four, unless in column with others exceeding four, to be without comma, thus : 1907.

References to be placed in foot-notes, giving title in italics, thus : *Alfred James. *Cyanide Practice*, p. 94 ; † H. Brown. *Mines and Minerals*, vol. xiii., p. 130; ‡ *Trans. Aust. Inst. M.E.*, vol. x, pp. 98-189.

Quotations to be indicated by inverted commas, and when lengthy, to be set in smaller type, with inverted commas at beginning and end only. Foreign terms to be in italic.

Localisms to be in inverted commas with their ordinary technical definition in parenthesis.

Drawings (on tracing cloth if possible), photographs (unmounted glossy-surface bromides) or other glossy-surface prints, &c., both for exhibition and for publication, are most desirable with almost every communication, and should always be on separate paper from the MS. Blue-prints only to be forwarded when original plans or tracings are not procurable. When reference letters are used in drawings for purposes of description, they are best thus : *a b c*, etc. Lettering and figuring on drawings should be large to allow of reduction to page size whenever possible. All lines should be black and firm. Each drawing should be accompanied by scale thus :—



N.B.—When in doubt about any point, it would be advisable to communicate with the Secretary.

LIST OF MEMBERS

OF THE

AUSTRALASIAN INSTITUTE OF MINING ENGINEERS.

* Fellow. † Honorary member. ¶ Life member. F Foundation member.

§ Author of paper.

MEMBERS.

Names and Addresses.	Date of Election.
Adam, John, Gt. Sons of Gwalia Mine, Gwalia, W.A. ..	1910
Adams, Ernest F., Box 5, P.O., Thames, N.Z.	1900
Adams, James Henry, Thames, N.Z.	1911
Agnew, John A., 1 London Wall Buildings, London, E.C. ..	1909
§Allen, Francis Bowen, 33 Colin-street, West Perth, W.A. ..	1900
Anderson, J. R. V., School of Mines, Bendigo, Vic. ..	1910
§Aplin, Wm., Mt. Morgan Technical College, Mt. Morgan, Q. ..	1905
Armstrong, Andrew S., Rhodesian Lead and Zinc Syndicate, Broken Hill, Rhodesia, South Africa	1912
Ashcroft, J. W., c/o R. N. Kirk, 16 O'Connell-street, Sydney, N.S.W.	1903
§Atkinson, Alfred Ashley, Mines Department, Sydney, N.S.W.	1912
Avery, John, Electrolytic Zinc Co., Hobart, Tas... ..	1912
Baker, William H., School of Mines, Thames, N.Z. ..	1911
Banks, Charles A., 155 Sloane Street, London, S.W. ..	1911
§Banks, Edwin G., Box 28, P.O., Waihi, N.Z.	1910
Baragwanath, Wm., Geological Survey Office, Mines Depart., Ballarat, Vic.	1915
Barker, Geo., Rosebery, Tas.	1915
Barr, James (jun.), Kaula Lumpur, Fed. Malay States ..	1913
Barton, B. V., The Seoul Mining Co., Hol Kol, Whang-Hai Province, Chosen, Korea	1910
Basedow, Erwin, Pirie-street, Kent Town, S.A.	1906
Bassett, John, Hall-street, Hokitika, N.Z.	1911

Names and Addresses.	Date of Election.
BATTENS, HENRY, Grenville United Mines Ltd., Camborne, Cornwall, England	1900
BEAMISH, W. A., Briseis Company, Derby, Tas.	1904
§BEAUMONT, EDWIN K., "Kenilworth," 24 Lewis-street, Lamington-heights, Kalgoorlie, W.A.	1899
BEECH, HAROLD, Sons of Gwalia Mine, Gwalia, W.A. ..	1919
§BELL, DR. JAMES MACKINTOSH, Almonte, Ontario, Canada ..	1906
BENNETT, V. C., Electrolytic Zinc Co., Collins House, 360 Collins-street, Melbourne, Vic.	1914
BENNIE, BOYD, Inspector of Mines, Huntley, N.Z. ..	1911
BLACK, ROBERT S., Kalgurli G.M. Co., Fimiston, W.A. ..	1909
BLACKETT, CHARLES E., Golden Horseshoe Estates Co. Ltd., Boulder, W.A.	1909
¶§BLAKEMORE, G. H., 4 Bridge-street, Sydney, N.S.W. ..	F.
§BOHM, HORACE SANFORD, "The Range." Rockhampton, Q...	1898
BOYD, ADAM A., Mount Morgan G.M. Co., Ltd., Mount Morgan, Q.	1906
BRADFORD, LESLIE, Broken Hill Pty. Co., Iron and Steel Works, Newcastle, N.S.W.	1910
BRAY, G. E., Charters Towers, Q.	1908
BRETT, HENRY TYNDALL, Albany Chambers, Bulawayo, Rhodesia, South Africa	1912
§BRINSDEN, FREDERICK G., Kalgurli G.M. Co., Fimiston, W.A.	1909
¶§BROOME, GEORGE H., State Coal Mine, Wonthaggi, Vic. ..	1900
BROWN, FRED B., Box 1353, P.O., Sydney, N.S.W. ..	1912
§BROWN, GEORGE F. CAMPBELL, Mount Morgan, Q.	1910
§BROWNE, D. H., State Coal Mine, Wonthaggi, Vic. ..	F.
BUCKLEY, HENRY, Zinc Corporation Ltd., Broken Hill, N.S.W.	1901
BUTEMENT, THOMAS, School of Mines, Kalgoorlie, W.A. ..	F.
CAMPION, G. W., 18 Carson road, Dulwich, S.E., London	1901
CARROLL, JOHN J., Kuaotunu, Auckland, N.Z.	1911
CHAMBERS, PRESTON, 22 Shortland-street, Auckland, N.Z. ..	1912
§CHAPMAN, PROFESSOR R. W., The University, Adelaide, S.A.	1901
CHAPPLE, ALBERT J. M., Mount Boppy G.M. Co., Canbelego, N.S.W.	1906
CHOMLEY, W. B., Zinc Corporation Ltd., Broken Hill, N.S.W.	1912
CHURCH, KENNETH C., Broken Hill Pty. Co., Newcastle, N.S.W.	1913
CLARK, LINDESAY C., Derby, Tas.	1905
CLARKE, HUNTLEY J., Queenstown, Tas.	1901

Names and Adresses.	Date of Election.
Clayton, C. H. J., Misima, Papua	1913
§Cleland, W. Lauder, Broken Hill Pty. Co., Iron and Steel Works, Newcastle, N.S.W.	1907
§Coldham, J. C., C.S.A. Mine, Cobar, N.S.W.	1907
Colley, Walter, Percyville, via Einasleigh, via Cairns, Q...	1914
Conder, Hartwell, Cranbourne-road, Frankston, Vic. ..	1915
Connor, J. D., 144 Barnard-street, North Adelaide, S.A. ..	1910
Coote, Frank J., 21 Royal-crescent, Camberwell, Vic. ..	1905
Copland, Maurice Osric, School of Mines, Ballarat, Vic. ..	1904
Corbould, W. H., Mt. Elliott Ltd., Selwyn, via Townsville, Q.	1908
§Courtney, Charles Frederick, Sulphide Corporation Ltd., 34 Queen-street, Melbourne, Vic.	1901
§Cowles, Richard K., New Sylvia G.M. Co., Box 55, P.O., Thames, N.Z.	1911
Crozier, Robert H., Hampden-Cloncurry Copper Mines Ltd., Kuridala, North Q.	1909
Crutchett, Edgar A., Great Boulder G.M. Co., Boulder, W. A.	1909
§Cunningham, John C., Broken Hill South Co., Broken Hill, N.S.W.	1902
Currie, David, 30, 31 St. Swithens-lane, London, E.C. ..	1911
Daggar, H. James, Queen's Bridge Square, South Melbourne, Vic.	1901
§Davies, H. Warlow, "Lormont," Gerald-avenue, Roseville, Sydney, N.S.W.	1910
Dawson, Edward H., 18 Exchange, Broken Hill, N.S.W. ..	1910
§Delprat, Guillame D., Broken Hill Pty. Co., Equitable Buildings, Melbourne, Vic.	1902
De Lautour, E. A., Ethridge Gold Mines, Forsayth, North Q.	1910
§Denny, G. A., Royal Society's Club, St. James-street, London	F.
§Dibdin, T. R., Broken Hill Associated Smelters, Port Pirie. S.A.	1910
Dickson, Gordon F., London & Rhodesian Mining & Land Co., 5 Moorgate-street, London	1909
Dixon, Clement, Box 305, P.O., Bulawayo, Rhodesia, South Africa	1900
¶Dobbie, H. Campbell, Box 318, P.O., Rangoon, Burma ..	1911
Dods, Richard, Electrolytic Refining and Smelting Co., Port Kembla, S.A.	1910
Donaldson, James, Box 272, P.O., Cairns, North Q. ..	1914
§Donaldson, Robert J., Central Mine, Broken Hill, N.S.W.	1905

Names and Addresses.	Date of Election.
Donnelly, Alf., c/o Mrs. Patterson, Argent-street, Broken Hill, N.S.W.	F.
Doolette, Dorham L., Nat. Mut. Buildings, St. George's-terrace, Perth, W.A.	1909
Drage, James, Ivanhoe Gold Corporation, Boulder, W.A. ..	1909
§Driffield, E. Carus, Queenstown, Tas.	F.
Dubois, A. J., c/o Chartered Bank of Australia and China, 38 Bishopsgate, London, E.C.	1908
Dunn, A. C., Central Mine, Broken Hill, N.S.W.	1908
Dyason, Edward C., Equitable Building, Melbourne, Vic.	1906
§Dyson, Thomas Ingleby, c/o Australasian Institute of Mining Engineers, 48 Queen-street, Melbourne, Vic... ..	F.
Eastaugh, Frederick A., University Club, Sydney, N.S.W.	1910
Eaton, J. Murdoch, Royalist Mine, Que Que, Rhodesia, South Africa	1905
§Edmands, H. R., Rivernia South G. M. Co., Menzies, W.A.	1901
Edquist, Victor T., Youanmi Gold Mines Ltd., Youanme, W.A.	1909
Espie, Frank F., Burma Mines Ltd., Bawdwin, Upper Burma	1918
Evans, F. H., Sulphide Corporation Ltd., Boolaroo, N.S.W.	1911
Evans, H. A., Sulphide Corporation Ltd., Boolaroo, N.S.W.	1911
Evans, James H., Gold and Scheelite Pty. Ltd., Golden Point, Macrae's Flat, Otago, N.Z...	F.
Ewart, John, North Broken Hill Mine, Broken Hill, N.S.W.	1910
§Fairweather, Andrew, Broken Hill South Mine, Broken Hill, N.S.W.	1912
Farrier, William Charles Valentine, P.O. Box 28, Broken Hill, N.S.W.	1913
Faul, Charles, "Moola," St. Leonard's-avenue, St. Kilda, Vic.	1910
Fisher, D. H., Mount Morgan, Q.	1907
Ford, H. W., 9 Freeman-street, North Fitzroy, Vic. ..	F.
Foster, Donald F., The Cliffe, Belmont, Sutton-Surrey, England	1913
Frazer, Alex., Great Boulder Pty. Ltd., Boulder, W.A ..	1909
Fraser, Donald Lovat, Blackwater, Q.	1910
Fraser, Colin, c/o Broken Hill Associated Smelters, Collins House, 360 Collins-street, Melbourne, Vic.	1911
§Fraser, S. E., Broken Hill Associated Smelters, Port Pirie, S.A.	1911
Fray, Percival Richard, McMahon-street, St. Arnaud, Vic.	1910

Names and Addresses.	Date of Election.
Freeman, Charles Cuthbert, Zinc Corporation Ltd., Broken Hill, N.S.W.	1913
Gall, Wm. C., North Mine, Broken Hill, N.S.W.	1910
Garde, Henry Thomas, Great Boulder Perseverance Gold Mining Co., Fimiston, W.A.	1913
Gardner, W. E., Central Mine, Broken Hill, N.S.W. ..	1902
Garland, Charles L., 11 Moore-street, Sydney, N.S.W. ..	1898
§Gartrell, H. W., The University, Adelaide, S.A.	1910
Gepp, Herbert W., c/o Electrolytic Zinc Co. of Aust., Collins House, 360 Collins-street, Melbourne, Vic. ..	1910
Gibson, Angus A., Mount Morgan, Q.	1910
§Gilmour, Jas. L., Waihi, N.Z.	1904
Godden, F. W. R., Ivanhoe Gold Corporation Ltd., Boulder, W.A.	1911
Gosman, William Alexander, Queenstown, Tas.	1913
Gray, George J., Gt. Western Hotel, Cobar, N.S.W. ..	1912
Greenway, T. J., 60 Queen-street, Melbourne, Vic. ..	F.
Greig, E H. c/o Burma Mines Ltd., Nam Tu, Northern Shan States, Burma	1916
Grierson, J. J., Jumbunna Coal Mine, Jumbunna, Vic. ..	1911
§Gunn, Francis, Finnis-street, Gawler, S.A.	1910
Hack, Clem. A., 360 Collins-street, Melbourne, Vic. ..	1905
Hales, Robert G., Magnet, Tas.	1914
§Hall, John F., 14 New Zealand Chambers, Queen-street, Brisbane, Q.	1918
Hamilton, Henry J. E., British Mine, North Broken Hill, N.S.W.	1910
§Hamilton, Richard, Great Boulder Pty. G.M. Co., Boulder, W.A.	1906
Hancock, H. Ley, Nungarin, via Merredin, W.A.	1901
§Hancock, H. Lipson, Moonta Mines, S.A.	F.
Hansen, L., Ajax North Mine, Daylesford, Vic.	1908
Hardman, James T., Torrington, N.S.W.	1913
Hargraves, E. P., c/o David & Toft, Singapore	1915
§Hart, G. Stephen, Commonwealth Cement Co., Portland, N.S.W.	1910
Hasson, Robt., Hagelthorne-street, Wonthaggi, Vic. ..	1915
Hay, Archibald L., Bullfinch Pty., Bullfinch, W.A. ..	1909
Hayes, William H., Moonta Mines, Moonta, S.A.	1910

Names and Addresses.	Date of Election.
§Hebbard, James, Central Mine, Broken Hill, N.S.W. ..	1902
Henderson, Edwin T., Broken Hill Pty. Co., Broken Hill, N.S.W.	1910
§Herman, Hyman, Mines Department, Treasury Buildings, Melbourne, Vic.	1897
Hetherington, J. W., M. L. A. Chambers, Queen-street, Brisbane, Q.	1911
Higgin, Alfred J., The University, Melbourne, Vic. ..	1912
Hitchcock, W. E., Bismuth, Tin and Wolfram Mine, Moina, near Wilmot, Tas.	1904
Hofman, Prof. H. O., Massachusetts Institute of Technology, Boston, Mass., U.S.A.	1914
Horsburgh, James, Mount Morgan G.M. Co. Ltd., Mount Morgan, Q.	1908
§Horwood, E. J., Broken Hill, N.S.W.	1902
Howden, John McA., The Bungalow, Roche, Cornwall, England	1913
Howe, A. Maxwell, Department of Mines (State Batteries Branch), Perth, W.A.	1901
Hughes, Joseph Albert, School of Mines, Charters Towers, Q.	1911
Hunter, Peter, State Coal Mine, Wonthaggi, Vic. ..	1912
§Hunter, Stanley B., Mines Department, Treasury Buildings, Melbourne, Vic.	1894
Hylton, C. G., Zinc Corporation Ltd., Broken Hill, N.S.W.	1906
Ikeda, Kenzo, c/o Fujita & Co., Dojima, Osaka, Japan ..	1918
Imanaga, T., Müke, Japan	1917
Ireland, Mark, South Cameron, Tas.	1902
§Jakins, G. Fred., North Lyell, Tas.	1910
James, Eric L., P.O., Lake Boga, Vic.	1910
James, John C., "Boomerah," Wetherall-street, Croydon, Sydney, N.S.W.	1913
§Jarman, Arthur, "Gosford," Mt. St. John's-avenue, Auckland, N.Z.	1910
§Jensen, E. Broughton, "Cimbria," East Terrace, Adelaide, S.A.	1909
§Jensen, William S., Mount Morgan G.M. Co. Ltd., Mount Morgan, Q.	1908
§Johns, Frederick C., c/o Junction North Mine, Broken Hill, N.S.W.	1911

Names and Addresses.	Date of Election.
JOHNS, MORGAN J., Mount Morgan G.M. Co. Ltd., Mount Morgan, Q.	1909
§JOHNSTON, W. H., Waihi, N.Z.	1904
JOICE, JOHN, c/o A. Victor Leggo & Co., Transvaal Mine, Southern Cross, W.A.	1918
§JONES, DAVID, Waratah, Tas.	F.
JONES, HENRY, Inspector of Mines, Kadina, S.A.	1910
JUDGE, JAMES, Ravenswood, North Q.	1911
JULIUS, ARCHIBALD C., C.S.A. Mine, Cobar, N.S.W. ..	1919
§KAYSER, H. W. FERD., "Offendene," Crimea-street, St. Kilda, Vic.	F.
§KENYON, A. S., State Rivers and Water Supply Commission, Treasury Gardens, Melbourne, Vic.	1896
KEY, JOHN F., British Mine, North Broken Hill, N.S.W. ..	1912
KING, A. J., c/o A. W. Freeman, Taiping, Perak, Fed. Malay States	1911
KING, E. M., "Leura," Launceston, Tas.	F.
KINGSTON, WM., School of Mines, Bairnsdale, Vic.	1914
§KITSON, ALBERT E., 109 Worple-road, Wimbledon, Surrey, England	1904
KLUG, GEO. C., c/o Bewick, Moreing and Co., 360 Collins-street, Melbourne, Vic.	1909
LADD, DAVID H., 615 Market-street, Seandersky, O., U.S.A.	1911
LAKELAND, WILLIAM J., Bandwin Mines, via Mampwe, Northern Shan States, India	1913
§LARCOMBE, C. O. G., School of Mines, Kalgoorlie, W.A. ..	1908
LAUN, ERNEST J., Inspector of Mines, Charters Towers, Q...	1909
§LAVERS, HERBERT, Block 14 Mine, Broken Hill, N.S.W. ..	1910
LEARMONT, TOM, Broadway, Reefton, N.Z.	1911
§LEDEBOER, J. H., Broken Hill Pty. Co., Broken Hill, N.S.W.	1913
LEGGO, A. VICTOR, Metallurgical Works, Bendigo, Vic. ..	1908
LEGGO, H. M., Mount Korrong-road, Job's Gully, Bendigo, Vic.	1901
LEITCH, WALTER, Blackball, N.Z.	1911
LESTER, THOMAS, Mount Morgan Extension Co. Ltd., Mount Morgan, Q.	1911
LEWIS, ESSINGTON, Broken Hill Pty. Ltd., Equitable Building, Melbourne, Vic.	1918
§LEWIS, JAMES B., 31 Queen-street, Melbourne, Vic. ..	1906

Names and Addresses.	Date of Election.
LIDGEY, CECIL R., G. H. & Co., Vickery's Chambers, 76 Pitt-street, Sydney, N.S.W.	1911
LILBURNE, ALBERT S., Mary Mac G.M. Co., Laverton, W.A.	1911
LINDSAY, JOHN A., Broken Hill, N.S.W.	1906
LOCKYER, ORMONDE H. S., Edwards Metallurgical Works, Sebastopol, Ballarat, Vic.	1910
LORING, W. J., 62 London Wall, London, E.C.2. ..	1909
§LOW, V. F. STANLEY, c/o National Bank of Australasia, 5 Bishopsgate, London, E.C.	1902
LUND, JENS, 64 Clyde-road, Addiscombe, Surrey, England ..	1902
LYONS, C. M., c/o Radcliff & Co. Ltd., Kanbauk, via Tavoy, Lower Burma	1916
MACARTNEY, E. H. B., 53 Lewis street, Kalgoorlie, W.A ..	1901
§MACDIARMID, ARCH. C., Reotahi, Whangarei Heads, Auckland, N.Z.	1911
MACGEORGE, ALEX. J., St. Georges-crescent, Glen Iris, Vic. ..	1911
MACKENZIE, D. C., Inspector of Mines, Wangaratta, Vic. ..	1910
MACLEOD, PETER J., The University, Hobart, Tas. ..	1901
MACNICOL, A. N., 31 Queen-street, Melbourne, Vic. ..	1906
MACROSSAN, BRIAN, Albion, Brisbane, Q.	1908
M'CONACHIE, WM., Waihi Grand Junction Co., Waihi, N.Z. ..	1910
M'CORMICK, W. J., Broad-street, Thames, N.Z.	1912
M'GEACHIE, DUNCAN, Caledonian Collieries Ltd., Newcastle, N.S.W.	1912
M'GEACHIE, JOHN, Caledonian Coal Co., Waratah Colliery, Charleston, N.S.W.	1908
M'KEOWN, MAURICE R., Vegetable Creek Tin Mine, Emmaville, N.S.W.	1912
§M'LEISH, JOHN, State Coal Mine, Wonthaggi, Vic. ..	1912
M'PADDEN, JOHN F., School of Mines, Reefton, N.Z. ..	1911
MARRYAT, CYRIL B., c/o C. H. Marryat, 33 Grenfell-street, Adelaide, S.A.	1910
MARS, F. J., Broken Hill South Mine Ltd, Broken Hill, N.S.W.	1902
MARSHALL, REGINALD R., Gibbs, Bright & Co., 27 Grenfell-street, Adelaide, S.A.	1910
MARTIN, EDWARD, Shire Hall, Bright, Vic.	1902
§MATHERS, J. V. W., Mararoa Gold Mining Co., Light of Asia Mine, Cue, W.A.	1914
§MATHESON, ALEX. M., Waratah, Tas.	1913

Names and Addresses.	Date of Election.
§Matters, Clem. W., High-street, Unley Park, Adelaide, S.A.	1910
§Mawdsley, W. H., P.O., Rockhampton, Q.	1898
Meredith, David, Electrolytic Zinc Co., Hobart, Tas. ..	1910
Merrill, Chas. W., Room 502, 121 Second-street, San Francisco, Cal., U.S.A.	1908
Merrin, Arthur H., Mines Department, Treasury Buildings, Melbourne, Vic.	1903
Messenger, William T., Zinc Corporation Ltd., Broken Hill, N.S.W.	1913
§Mickle, Kenneth A., c/o Argus Office, 80 Fleet-street, London	1909
Millett, Bert, Hodgkinson-street, Charters Towers, Q. ..	1907
Mitchell, John P., Atlas Buildings, 8 Spring-street, Sydney, N.S.W.	1909
§Mitchell, S. R., Burnley-street, Richmond, Vic. ..	1912
Moen, Oluf, St. Bathans, Central Otago, N.Z.	1911
Moline, Arthur H. P., Bendigo Amalgamated Goldfields, N.L., Bendigo, Vic.	1909
Molineaux, Herbert S., The Reefs, Central Otago, N.Z. ..	1911
§Montgomery, A., Department of Mines, Perth, W.A. ..	F.
Moore, Karl Byron, c/o H. Byron Moore, 367 Collins-street, Melbourne, Vic.	1913
Moore, Robert M'I., Macquarie-street, Dubbo, N.S.W. ..	1912
§Morgan, Percy G., Geological Survey Office, Wellington, N.Z.	1900
Morse, Phillip S., 157 Walnut-street, Brooklyn, Mass., U.S.A.	1905
Morse, Willard S., Seaford, Delaware, U.S.A.	1901
§Moss, Frank A., Greenbushes, W.A.	F.
Moulden, J. C., Central Zinc Co., Seaton-Carew, near Middlesborough, England	1906
Moule, John W., Burma Mines Ltd., Bawdwin, Upper Burma	1908
Moxon, Claude H. Hercules Gold and Silver Mining Co., Williamsford, Tas.	1915
Mulligan, W. J., Grafton Copper Mines, Cangai, N.S.W. ..	1910
Murdoch, Fredk. M., Hampden-Cloncurry Copper Mines Ltd., Cloncurry, North Q.	1915
Murphy, Frank, Great Cobar Ltd., Cobar, N.S.W. ..	1912
Murray, Geo. D., Ivanhoe Gold Corporation Ltd., Boulder, W.A.	1909
§Murray, Russell M., Mount Lyell Mine, Gormanston, Tas.	1911

Names and Addresses.	Date of Election.
MURRAY, VIRGINIUS H. R., 35 Killarney-street, Kalgoorlie, W.A.	1909
NAKAMURA, KEIJIRO, Baron Sumitomo's General Head Office, Kitahama, Osaka, Japan	1914
§NEWMAN, J. MALCOLM, Pratten Buildings, Jamieson-street, Sydney, N.S.W.	1910
NICOL, W. J., "Dieppe," Alexandra, Vic.	1910
NICHOLSON, L'ESTRANGE, Mount Elliott Mine, Selwyn, Q.	1913
NOBLE, JAS. R., Junction-road, Waihi, N.Z.	1910
O'BRIEN, EDWARD, c/o Broken Hill Pty. Ltd., Box 196, Newcastle, N.S.W.	1910
O'BRIEN, KIRK, 360 Collins-street, Melbourne, Vic.	1911
OWEN, T. MACKELLAR, 116, 118 Clarence-street, Sydney, N.S.W.	1914
§PALMER, THOS. H., Collins House, 360 Collins-street, Melbourne, Vic.	1910
§PATTERSON, B. G., Mount Morgan, Q.	1907
PAUL, MATTHEW, Inspector of Mines, Waihi, N.Z.	1910
§PAULL, W. J., "Codrington," Bowenville, Darling Downs, Q.	F.
PAYNE, PROFESSOR HENRY, The University, Melbourne, Vic.	1911
§PEARCE, W. C. WALWORTH, Lancelot, via Herberton, Q.	1906
PEARSON, J. L., Wallaroo Mines, S.A.	1913
PEBERDY, JAMES R., c/o Dr. Davis, "Cahore," Bay-street, Port Melbourne, Vic.	1910
PENMAN, ARTHUR PERCY, City Bank Chambers, Newcastle, N.S.W.	1911
PETTIT, ARTHUR E., 8 Old Jewry, London, E.C.	1905
§POOLE, WM. (Julius & Poole), Culwulla Chambers, Castlereagh-street, Sydney, N.S.W.	1905
POMROY, H., Wallaroo Mines, S.A.	1913
§POWER, F. DANVERS, Perpetual Trustees Chambers, 33-39 Hunter-street, Sydney, N.S.W.	F.
RAE, CECIL, Ipoh, Perak, Fed. Malay States	1908
RANKIN, WM. C. F., Howard, Q.	1908
READ, THOMAS A., "Warrawee," Thomas-street, Broken Hill, N.S.W.	1918
REID, A. M'INTOSH, Geological Survey Offices, Launceston, Tas.	1919
REID, MAJOR D. E., Gympie, Q.	1910
RHODES, CHARLES, Ronaki, Remuera, Auckland, N.Z.	1911
§RHODES, FRED. N., New Zealand Portland Cement Co., Limestone Island, N.Z.	1910

Names and Addresses.	Date of Election.
§Richard, G. A., Queensland Club, Brisbane, Q.	1895
Ridge, H. M., 2 Gt. Winchester-street, London, E.C. ..	1901
Rickleman, H., c/o Electrolytic Refining Co., Port Kembla, N.S.W.	1907
§Rigby, Edward J., 482 Collins-street, Melbourne, Vic. ..	F.
Rigg, Gilbert, Broken Hill Associated Smelters Ltd., 360 Collins-street, Melbourne, Vic.	1917
Roberts, Geo. M., Associated Northern Blocks (W.A.) Ltd., Kalgoorlie, W.A.	1909
§Roberts, Nicholas J., Central Mine, Broken Hill, N.S.W. ..	1913
Rodda, E. J. J., "Ensanada," Murdock-street, Cremorne, Sydney, N.S.W.	1907
Rodda, Stanley N., Melbourne Technical College, Melbourne, Vic.	1910
Rolfe, R. A., 53 West-street, North Sydney, N.S.W. ..	1915
Rose, Walter J., Amalgamated Zinc (De Bavay's) Ltd., Broken Hill, N.S.W.	1909
Rowe, F. Walton, Oroya Links Ltd., Kalgoorlie, W.A. ..	1913
Rusha, Richard A., "Villette," Narbourne-avenue, Clapham Common, London, S.W.	1912
Russell, Murray, Inspector of Mines, c/o Dept. of Mines, Brisbane, Q.	1912
Ryan, Cecil G., Bradshaw's Creek, Tas.	1908
Sander, George E., Rhodesian Lead and Zinc Syndicate Ltd., Broken Hill, Rhodesia, South Africa	1910
§Sarvaas, Johan, Melbourne Technical College, Melbourne, Vic.	1902
Saunders, George J., Central Technical College, Brisbane, Q.	1904
Savage, A. E., "Nangeela," Point-road, Woolwich, Sydney, N.S.W.	1911
Schlapp, H. H., Collins House, 360 Collins-street, Melbourne, Vic.	F.
Scoble, E. J., Adams-street, Waihi, N.Z.	1917
Scott, Malcolm B., Kalgurli G.M. Co., Fimiston, W.A. ..	1909
Scott, James Balfour, Renison Bell, Tas.	1913
Shaw, J. B., c/o A. B. S. White, Vickery's Chambers, 82 Pitt-street, Sydney, N.S.W.	1910
Shepherd, H. Frank, Thames, N.Z.	1911
§Skeats, Professor E. W., The University, Melbourne, Vic.	1905
§Slee, Richard T., Broken Hill Pty., Co., Newcastle, N.S.W.	1902

Names and Addresses.	Date of Election.
§Slessor, Robt., Castlereagh House, Castlereagh-street, Sydney, N.S.W.	1905
Smith, A. Mica, School of Mines, Ballarat, Vic.	1906
Smith, C. E. Kennedy, State Battery, Ora Banda, W.A. ..	1912
Smith, C. Lonsdale, MacDonald Kitchener Molybdenite Mines Ltd., Almaden, Q.	1905
§Smith, F. Voss, Block 14 Co., Broken Hill, N.S.W. ..	1909
Smith, J. D. Audley, Box 1557, P.O., Sydney, N.S.W. ..	1910
Somerset, H. St. J., Jun., Broken Hill Associated Smelters, Port Pirie, S.A.	1898
Speight, Robert, Canterbury Museum, Christchurch, N.Z.	1911
Stephens, J. Farish, Junction North Mine, Broken Hill, N.S.W.	1918
Stephenson, Clement T., 39 Wrixon-street, East Kew, Vic.	1912
Stewart, Farquhar, Walsh-street, Reefton, Westland, N.Z.	1910
¶§Stewart, Hector, "Solai," Wagin, W.A.	1902
§Sticht, Robert C., Mount Lyell Mining and Railway Co., Queenstown, Tas.	1901
Stirling, J., Burnie, Tas.	F.
Stokes, C. H.. Sth. Kalgurli G.M. Co., Box 100, P.O., Fimiston, W.A.	1910
Stokes, Reginald H., "Labrena," Beaconsfield-road, Mosman, N.S.W.	1911
Strambini, Dominico, Deighton-street, Ravenswood, North Q.	1913
Süssmilch, C. A., Technical College, Newcastle. N.S.W. ..	1904
Sutherland, John W., Golden Horseshoe Estates Ltd., Boulder, W.A.	1909
Sutherland, Wm. G., Smelting Works, Fremantle, W.A. ..	1909
Taylor, E. Hogan, Great Cobar Ltd., Cobar, N.S.W ..	1913
Thomas, Harry A., Carisbrook, Vic.	1910
Townsend, C. T., Cyanide Works, One-Mile, Gympie, Q. ..	1908
Trenerry, Edward, Moonta Mines, S.A...	1911
Turnbull, T. A., 164 Hardy-street, Nelson, N.Z.	F.
Turner, A. D., Falcon Mines Ltd., via Umvuma, Rhodesia, South Africa	1913
§Turri, G. G., The Rialto, Collins-street, Melbourne, Vic. ..	F.
Ullman, A. T., Clarendon Hotel, Hunter-street, Newcastle, N.S.W.	1914
Ulrich, Gerhardt A., c/o Inst. of Mining and Metallurgy, Salisbury House, London Wall, London, E.C. ..	1911

Names and Addresses.	Date of Election.
WADDELL, W. A., Koorboora, via Cairns, Q.	F.
§WAINWRIGHT, W. E., Broken Hill South Mine, Broken Hill, N.S.W.	1902
§WALLMANN, H. P., Thistle-street, Bendigo, Vic. . ..	1910
WALTON, ROBERT W., 324 Bondi-road, Bondi, N.S.W. ..	1911
WARD, L. KEITH, Director of Mines, Department of Mines, Adelaide, S.A.	1918
WARDE, HARVEY S., Inspector of Mines, Court House, Rockhampton, Q.	1907
WARNE, GEORGE, Grey-street, Thames, N.Z.	1911
WATERHOUSE, LESLIE V., c/o Mount Lyell Mining and Railway Co., Queenstown, Tas.	1910
§WATERS, PROFESSOR D. B., The University, Dunedin, N.Z.	1904
WATSON, JAMES T., Chillagoe Ltd., Mt. Mulligan, via Cairns, Q.	1911
WAUCHOPE, A., Johnstone-street, Cottesloe, W.A.	1909
WEBSTER, WILLIAM W., Intan, Upper Perak, Fed. Malay States	1912
WEIGALL, A. R., c/o Seoul Mining Co., Suan Mine, Hol Kol, Whang Hai Province, Korea	1910
WEIGALL, HENRY STUART, Chosen Gold Mines Ltd., Seoul, Korea	1912
WEINBERG, E. A., 45 Broadway, New York, U.S.A. ..	F.
WEIR, GEORGE, 360 Collins-street, Melbourne, Vic.	1902
WENTWORTH, D'ARCY, 3 Onslow-avenue, Elizabeth Bay, Sydney, N.S.W.	1898
WESTCOTT, L. A., "Catumnal," Corfield, Q.N.R., Q. ..	1907
§WHITE, EDMOND A., Electrolytic Refining Co., Port Kembla, N.S.W.	1900
WHITE, FRANCIS P., Goonengerry, via Mullunbimby, North Coast, N.S.W.	1913
§WHITE, NORMAN F., "Warrandaroo," Longerock, Q. ..	1899
WHITFELD, H. E., The University, Perth, W.A.	1914
WHITLEY, ALEXANDER, Inspector of Mines, Dunedin, N.Z. ..	1911
WILKINS, LAURENCE G., 2 Cooper-street, Double Bay, Sydney, N.S.W.	1913
§WILLIAMS, LUKE, "Claremont," Moonah, Tas.	1894
WILLIAMS, THOMAS H., Leonora G. Blocks, Leonora, W.A. ..	1910
WILSON, A. LAURENCE, New Ravenswood Ltd., Ravenswood, Q.	1909
WILSON, F. G., Y—Water Tin Co., N.L., Emmaville, N.S.W.	1910
WILSON, HARRY, 31 Queen-street, Melbourne, Vic. .	1914
WILSON, WILLIAM T. S., Extraction Works, Pæroa, Auckland, N.Z.	1911

Names and Addresses.	Date of Election.
WINTER, ARTHUR S., C.S.A. Mines Ltd., Cobar, N.S.W. ..	1918
§WOOD, JAMES P., School of Mines, Adelaide, S.A.	1910
WORSLEY, HENRY E., Broken Hill Pty. Co., Broken Hill, N.S.W.	1910
§WRIGHT, GEO. W., Mt. Lyell Mining and Railway Co., Queenstown, Tas.	1906
§WYLIE, WM., 121A Main Road, North East Valley, Dunedin, N.Z.	F.
YOUNG, GERALD W., "Rona," Toorak-road, Toorak, Vic. ..	1909

ASSOCIATE MEMBERS.

ALFORD, L. C., "Oakhampton," Wellington. N.Z.	1910
ANDERSON, A. F. S., Burma Mines Ltd., Nam Tu, Northern Shan States, Burma	1914
ATKINSON, J., Emmaville, N.S.W.	1907
AVERY, WILFRED P., Klong Sa Mine, Tammarat Mining Syndicate, Bandon, Siam	1910
BALDWIN, PERCY H., Mount Morgan, Q.	1910
BANKS, JOHN H. G., Waihi G.M. Co., Waihi, N.Z. ..	1910
BARCLAY, FRED. E., "Burra Bra," Thinkoswald Avenue, Mosman, Sydney, N.S.W...	1912
BARBER, C. S., Pell-street, Broken Hill, N.S.W.	1915
BARKER, NIGEL CHASE, Atlas Buildings, Spring-street, Sydney, N.S.W.	1911
BARKLEY, ERNEST, Mount Lyell Mining and Railway Co, Gormanston, Tas.	1906
BECKWITH, RALF N., Mount Gunson Mine, Port Augusta, S.A.	1910
BLACK, ARNOLD B., 8 Zebina-street, Broken Hill, N.S.W. ..	1912
BLYTH, WILLIAM B., P.O. Box 1, Salisbury, South Rhodesia	1911
BOYDELL, W. G. B., c/o Seoul Mining Co., Hol Kol Mine, Whang Hai Province, Chosen, Korea	1911
BOWATER, W. H., Thermo-Electric Ore Reduction Corporation, Wolfram, Q.	1910
BRIDGE, JOHN M., Zinc Corporation Ltd., Broken Hill, N.S.W.	1907
BROWN, G. TWENTYMAN, "Glenfern," Mathoura-road, Toorak, Vic.	1910
BROWN, H. WHEELER, Broken Hill Pty. Co., Broken Hill, N.S.W.	1913

Names and Addresses.	Date of Election.
BULLEN, G. L., Block 14 Torrington, Bismuth, via Deepwater, N.S.W.	1913
BURBIDGE, PERCY, Mount Shamrock Mine, Mount Shamrock, Q.	1910
CAITHNESS, W. R., c/o Fraser and Chalmers Ltd., Collins House, 360 Collins street, Melbourne, Vic.	1909
CAMPBELL, A. G., "Kia-Ora," Bay-road, Sandringham, Vic.	1911
CAMPBELL, J. K., Stannary Hills, via Cairns, Q.	1915
CARLESS, NOEL, Walney House, Waihi, N.Z.	1913
CHRISTIAN, ARTHUR J., The Ranch, Oxide-street, Broken Hill, N.S.W.	1910
CLAPP, L. P., 76 Chloride-street, Broken Hill, N.S.W. ..	1910
CLARK, ARCHIE S., Grafton Copper Co., Cangai, N.S.W. ..	1910
CLAYTON, EDWARD, Sons of Gwalia Mine, Gwalia, W.A. ..	1912
COLE, WILLIAM H., Waihi Grand Junction Ltd., Waihi, N.Z.	1912
COLLISON, ARTHUR G., King William-street, Adelaide, S.A...	1902
COOKE, HERBERT R., N.Z. Express Coy's. Building, No. 12 Fort-street, Auckland, N.Z.	1911
CORSTOPHAN, V. A., c/o Electrolytic Zinc Co. of Aust., Hobart, Tas.	1915
COURT, A. LACY, c/o E. H. Nutter, 825 Merchants Exchange Building, San Francisco, Cal.	1913
§COURTNEY, GUY, c/o Sulphide Corporation Ltd., Boolaroo, N.S.W.	1912
CRACE, MELVILLE C., Broken Hill South Mine, Broken Hill, N.S.W.	1911
CRAIG, J. H., Albion Chambers, Bendigo, Vic.	1911
CRIBB, H. B., Lower Quarters, Mount Morgan, Q.	1910
CUMMING, ALEX., Irvinebank Co., Irvinebank, North Q. ..	1911
DANKS, AARON T., 391 Bourke-street, Melbourne, Vic. ..	1905
DITCHBURN, GORDON L. A., Pahang Consolidated Co., Sungei Lembing, Pahang, Fed. Malay States	1910
DOD, H. CHARLTON, S.A. Oil Wells Co., Tantanoola, S.A. ..	1914
DOW, EDMUND B., Central Mine, Broken Hill, N.S.W. ..	1910
DOW, JOHN, Golden Horseshoe Estates Ltd., Boulder, W.A.	1910
§DRAIN, PERCY J., "Kingsley," Kitchener-road, Artarmon, Sydney, N.S.W.	1910
DUNSTAN, BASIL G., c/o Jno. Dunstan, Churchill Chambers, 61 Market-street, Sydney, N.S.W.	1911
§EDWARDS, ED., "Glenesk," Callintina-road, Hawthorn, Vic.	1907

Names and Addresses.	Date of Election.
Elford, Chas., Rishton, via Charters Towers, Q. ..	1910
Fisher, W. Hamilton, 46 Ward-street, Kalgoorlie, W.A. ..	1913
Flockart, Colin P., 58 Broadway, East Camberwell, Vic.	1912
Fox, James Michael, North Mine, Broken Hill, N.S.W. ..	1910
Foxall, John S., Longueville, Sydney, N.S.W.	1912
§Fry, Sidney, Westport, N.Z.	1907
Game, George B., South Silver Mine, Broken Hill, N.S.W.	1918
Getty, Andrew, 7 Victoria-street, Kalgoorlie, W.A. ..	1915
Gluyas, B. C., Broken Hill Pty. Ltd., Newcastle, N.S.W.	1913
Greening, Walter, Te Aroha, N.Z.	1911
Greenlees, Alan D., Amalgamated Zinc (De Bavay's) Ltd., Broken Hill, N.S.W.	1910
Grieve, William H., c/o William Adams and Co., 175 Clarence-street, Sydney, N.S.W.	1911
Grosse, William J., 63 Patton-street, South Broken Hill, N.S.W.	1913
Guppy, Clarence H. R., Nowra, N.S.W.	1911
Haigh, Victor A, Block 10 Mine, Broken Hill, N.S.W. ..	1910
Hammel, Henry E., "Yamba," Esplanade, St. Kilda, Vic.	1913
Harris, Frank G., Amalgamated Zinc (De Bavay's) Ltd., Broken Hill, N.S.W.	1910
Hart, William, Mount Lyell Mining and Railway Co., Gormanstown, Tas.	1913
Harvey, Phillip, School of Mines, Charters Towers, Q. ..	1910
Heycock, C. R., Moretown, Wairio, Southland, N.Z. ..	1914
Holder, Evan M., Central Mine, Broken Hill, N.S.W. ..	1910
Hooke, Arthur W., Forum River (Nigeria) Tin Co. Ltd., Naraguta, Northern Nigeria, West Africa	1911
Hookings, Herbert J., Assay Office, Broken Hill Pty. Ltd., Broken Hill, N.S.W.	1911
Hooper, Thomas H., Butlers Tin Mine, Torrington, N.S.W.	1919
§Hope, G. B., "Carrical," Hermitage-rd., Newtown, Geelong, Vic.	1911
Horsburgh W. W., Hampden-Cloncurry Copper Mines Ltd., Kuridala, North Q.	1911
Hunter, George M'I., Central Mine, Broken Hill, N.S.W.	1910
Irvine, C. L., Mill Stream Station, Roebourne, W.A. ..	1913
Jones, Vincent N., Jericho, Central Q.	1910
Klem, Leslie G., Noumea, New Caledonia	1919
Langford, Walter G., Vailala Oil Fields, Papua	1915

Names and Addresses.	Date of Election.
Lawn, Charles H. Opunake road, Stratford, Taranaki, N.Z.	1911
Leevers, William T., Great Boulder Perseverance G.M. Co., Fimiston, W.A.	1910
Le Souef, Sebert G., Butler's Tin Mine, Torrington, N.S.W.	1910
Lewis, K. B., "Remo," 41 Kooyong-road, Armadale, Vic. ..	1915
MacGruer, D. C., Sulphide Corporation Ltd., Boolaroo, N.S.W.	1915
Mackay, Alexander D., c/o Mount Bischoff Co., Waratah, Tas.	1913
M'Callum, N. S. Kellie, c/o Dr. R. W. Young, "Beckenham." 148 Botany-road, Botany, N.S.W.	1911
McKay, James, Box 55, P.O., Greymouth, N.Z.	1911
Montgomery, John N., Upoia, Papua	1914
§Moore, Malcolm S., 19 Queen-street, Melbourne, Vic. ..	1912
§Morgan, R. J., Spassky, Zavod, Akmolinsk, Siberia ..	1911
Morison, David N., Newcastle, N.S.W.	1911
Morris, A. C., Zinc Corporation Ltd., Broken Hill, N.S.W.	1913
Nevett, Ralph D., Thomas-lane, off Chloride-street, Broken Hill, N.S W.	1912
Newbigin, William J., c/o William Adams and Co., 521, 523 Collins-street, Melbourne, Vic.	1913
Osborne, George W., Meekatharra, W.A.	1913
§Ower, Leslie H., Mines Dept., Melbourne, Vic.	1910
Parker, Phillip a'M., Malayan Collieries, Batu Arang, Fed. Malay States	1918
Patterson, R. H., Broken Hill Club, Broken Hill, N.S.W.	1912
Rabling, H., 69 Primrose-street, Moonee Ponds	1914
Rain, Allan D. M., Braden Copper Mines, Rancagua, Chili, South America	1911
Reid, G. D., Box 17, P.O., Avoca, Vic...	1916
Robson, H. Carmichael, The Spassky Copper Mine Ltd., Akmolinsk, Siberia	1913
Rogers, George, Junction Mine, Broken Hill, N.S.W. ..	1913
Ross, C. N., c/o The University of Queensland, Brisbane, Q.	1907
Rutherford, Alex. R., Globe Mine, Reefton, N.Z. ..	1913
Rutherford, T. Wyville L., Consolidated Goldfields, Reefton, N.Z.	1913
Rutter, Hubert, "Yarra Braes," Eltham, Vic.	1908
Ryan, Denis L., Fremantle Trading Co., Fremantle, W.A...	1917
Salter, John W., 76 Chloride-street, Broken Hill, N.S.W. ..	1912
Sampson, Thomas, "Montana," High-street, Sheffield, Tas...	1919

Names and Addresses.	Date of Election.
Schwilk, B. J., 73 Burke-street, Railway Town, Broken Hill, N.S.W.	1911
Seale, Harry V., Junction North Mine, Broken Hill, N.S.W.	1910
§Sewell, Robert M., School of Mines & Industries, Stawell, Vic.	1913
Shaw, John F., Block 14 Mine, Broken Hill, N.S.W. ..	1912
§Shellshear, Wilton, c/o Burma Mines, Ltd., Nam Tu, Northern Shan States, Burma	1910
Simpson, James, Crown Law Dept., Perth, W.A.	1910
Skerritt, Alfred W., Kapsan Mines, Korea	1907
Sligo, A. D., Zeehan, Tas.	1911
Smith, H. Hardy, "Cora Lynn," Woolwich, Sydney, N.S.W.	1910
Smith, R. D., Hampden-Cloncurry Copper Mines Ltd., Trekelano, via Duchess, Cloncurry, Q.	1908
Smith, Walter G. A., Block 10 Mine, Broken Hill, N.S.W. ..	1912
Stanger-Leathes, A. C., 14 MacArthur-street, Ballarat, Vic.	1912
Stephen, Fenton W., Broken Hill Pty. Co., Broken Hill, N.S.W.	1910
Stephenson, Godfrey., "Kaiom," Paris road, Northwood, Sydney, N.S.W.	1917
Stephenson, Herbert, "Beaumaris," Fletcher-street, Bondi, Sydney, N.S.W.	1910
Stichnoth, Ludwig F., Box 47, P.O., Mt. Morgan, Q. ..	1910
Stutterd, Louis N., P.O., Port Darwin, Northern Territory	1910
Sweet, Oswald G., South Extended Mine, Broken Hill, N.S.W.	1910
Tandy, A. E., c/o Mrs. S. A. Writer, "Glen Rowan," Warreemba-road, Abbotsford, N.S.W.	1915
Thomas, Frank N., South Mine, Broken Hill, N.S.W. ..	1911
Thompson. F. D., c/o Eastern Smelting Co. Ltd., Penang, Straits Settlement	1908
Topp, A. A., 12 Cromwell road, Hawksburn, Vic.	1909
Townsend, Harold, "The Wurlie," Iodide-street, Broken Hill, N.S.W.	1910
Treloar, Fred. L., Oxide-street, off Morgan-lane, Broken Hill, N.S.W.	1913
Twine, George J., c/o N. S. West, Gretna Township, H.M. Factory, Gretna, Carlisle, England	1914
Vaughan, Rupert M., "The Batch," Briseis Tin Mine, Derby, Tas.	1911

Names and Addresses.	Date of Election.
WAINE, VICTOR J., Colonial Sugar Refining Co., Sigatoka, via Lantoka, Fiji	1908
§WARREN, P. HAMPTON, Broken Hill South Mine, Broken Hill, N.S.W.	1910
§WATKINS, AUGUSTUS E., St. Aubyn-street, New Plymouth, Taranaki, N.Z.	1911
WATSON, HERBERT, c/o Amalgamated Zinc (De Bavay's) Ltd., Broken Hill, N.S.W.	1911
WELLSTED, T. W., Collins House, 360 Collins Street, Melbourne, Vic.	1919
WHITE, FREDK. G. (White & Hosier), Broken Hill, N.S.W.	1911
WHITEHEAD, EDWIN A., "Aballaba," North Terrace, Kensington Gardens, S.A.	1902
WHITEMAN, WOODLEIGH D., The Cam and Motor Mines, Eiffel Flats, Southern Rhodesia, South Africa	1913
WHITINGTON, BERTRAM., Mt. Lyell School of Mines, Queenstown, Tas.	1915
WILLIAMS, ARTHUR, Oxide Creek Ltd., Mt. Gordon Mine, via Cloncurry, Q.	1915
WILLIAMS, OWEN B., Block 14 Mine, Broken Hill, N.S.W. ..	1910
§WILLIAMS, R. T. D., Amalgamated Zinc (De Bavay's) Ltd., Broken Hill, N.S.W.	1910
WILLIAMS, W. EWART, Block 10 Mine, Broken Hill, N.S.W.	1912
WILSON, WILFRED A., Lakes Creek, Q.	1911
WINTERS, R. J., 224 King-street, Newtown, Sydney, N.S.W.	1914
WOODWARD, OLIVER H., Officers Quarters, Mt. Morgan G.M. Co., Mt. Morgan, Q.	1909
ZEUGOFSGE, F. C., 228 Patton-street, South Broken Hill, N.S.W.	1910

STUDENTS.

ADCOCK, GARNET I., Viticultural College, Rutherglen, Vic...	1911
ALEXANDER, HUBERT, Black Range West G.M. Co., Sandstone, W.A.	1912
ANDERSON, ARCHIBALD G., "Leacroft," Parnell Place, E. Newcastle, N.S.W.	1913
ANDERSON, E. S., c/o R. E. Chapman, Bank of New South Wales, Ballarat, Vic.	1912

Names and Addresses.	Date of Election.
Anderson, Wm. T., "Clifton," Ben Boyd-road, Neutral Bay, N.S.W.	1910
Barson, Thomas L., Railway Town, Broken Hill, N.S.W. ..	1913
Berriman, Ralph V., "Bolton," Daphne-street, Prospect, S.A.	1913
Best, George H. T., Sons of Gwalia Ltd., Gwalia, W.A. ..	1911
Blair, F. A., Central Mine House, South Road, Broken Hill, N.S.W.	1912
Bloom, Leo, Merivale-street, South Brisbane, Q.	1913
Blunden, Leslie E., 228 Elizabeth-street, Brisbane, Q. ..	1910
Burns, Felix G., Terminus Hotel, Williamsford, Tas. ..	1914
Carroll, H. H., 3 Pleasant-street, Ballarat, Vic.	1915
Casey, Richard G., 125 William-street, Melbourne, Vic. ..	1909
Cherry, Henry W. S., "The Towers," Sulphide-street, Broken Hill, N.S.W.	1913
Combe, A. D., "Koombana," 47 Leicester-street, Parkside, S.A.	1912
Corrie, Colin C., Electrolytic Zinc Co., 360 Collins-street, Melbourne	1911
Craigie, A. K. Palace Hotel, Broken Hill, N.S.W. ..	1911
Crawford, H., School of Mines, Thames, N.Z.	1912
Dean, Harry M., School of Mines, Charters Towers, Q. ..	1911
Fabrikant, I. B., Empire Hotel, Queenstown, Tas. ..	1915
Fraser, Ernest H., Box 157, P.O., Broken Hill, N.S.W. ..	1911
Gabriel, G. Escott, 114 Westbury-street, St. Kilda, Vic. ..	1910
Goode, Kenneth B., Stephens-place, Adelaide, S.A. ..	1913
Grut, L. de Jersey, School of Mines, Ballarat, Vic. ..	1913
Hill, James, Box 27, P.O., Many Peaks, Q.	1907
Hooper, Francis H., Block 14 Mine, Broken Hill, N.S.W...	1911
Horn, A. E., Globe Mine, Reefton, N.Z.	1912
Horsley, Ralf D., Stannary Hills, North Q.	1910
Hughes, Eric W., American River, via Hog Bay, Kangaroo Island, S.A.	1913
Kelly, A. H., 1 Lemington-street, Glenelg, S.A.	1913
Kelly, Monckton B. H., Trinity College, Parkville, Melbourne, Vic.	1913
Kerr, Frederick T., c/o Zinc Corporation Ltd., Broken Hill, N.SW.	1918
Kneebone, Christopher S., Woodville-road, Woodville, S.A.	1914
Marks, Douglas G., "Sundridge," Lindsay-street, Neutral Bay, Sydney, N.S.W.	1912

Names and Addresses.	Date of Election.
MULLIGAN, EDRIC N., Box 89, P.O., Cobar, N.S.W. ..	1910
NICHOLAS, FRANK H., c/o F. G. T. Nicholas, Metal Exchange, Queen-street, Melbourne, Vic.	1913
PAULL, N. C., Hampton-Cloncurry Copper Mines Ltd., Cloncurry, North Q.	1910
PEARSON, H. F., Zinc Corporation Ltd., Broken Hill, N.S.W.	1912
PETHEBRIDGE, H. V., 48 Fellows-street, Kew, Vic., ..	1915
PLANT, G. H. D., "Thornburgh," Charters Towers, Q. ..	1910
ROBERTS, REGINALD A. J., "Clydeville," Beryl-street, Broken Hill, N.S.W.	1912
RUSSELL, JAMES L., c/o P. O'C. Russell, Elizabeth-street, Brisbane, Q.	1913
SMITH, EUGENE, 82 Victoria road, Auburn, Vic.	1913
SMITH, ROY S., "Spotswood," Hodgson-street, Randwick, Sydney, N.S.W.	1914
SMITH, W. F., School of Mines, Charters Towers, Q. ..	1913
SOUTHON, RONALD D., Broken Hill South Mine, Broken Hill, N.S.W.	1912
SYMONDS, G. B. L., The University, Adelaide, S.A. ..	1916
TAYLOR, AUGUSTUS, "Walsall," Ferrier-street, Rockdale, N.S.W.	1908
TAYLOR, E. FOULKES, c/o Mrs. C. F. Bethell, Cheam Park, Cheam, Surrey, England	1913
THOMPSON, DAVID, Cardross, Q...	1910
TURNER, WILLIAM A., Wentworth-avenue, Canterbury, Melbourne, Vic.	1914
UREN, WM. T., Kuridala, via Cloncurry, North Q. ..	1909
VEITCH, NEIL A., Hampton-Cloncurry Copper Mines Ltd., Kuridala, North Q.	1911
WILLIAMS, W. H. (JUN.), Assistant Inspector of Mines, Rockhampton, Q.	1914
WISHART, J. W., Naval Department, Williamstown, Vic. ..	1910
YATES, DONALD, Lefevre Terrace, North Adelaide, S.A. ..	1914

Australasian Institute of Mining Engineers.

EXTRACTS FROM RULES.

III.—MEMBERSHIP.

1. The Institute shall consist of three classes, viz., Members, Associate Members and Students.

2. MEMBERS shall be persons not under 25 years of age who, having occupied during a sufficient period a responsible position in connection with the practice or science of mining or metallurgy, may be considered by the Council to be qualified for election.

(NOTE.—The term "responsible position" covers persons in full charge of important mining or metallurgical operations, in practice as consulting Mining Engineers, engaged in teaching geology, mining or metallurgy in an important institution, or in employment as principal Geologists or Metallurgists in Government Departments and leading Mining Corporations, or Metallurgists after proper training and experience).

3. ASSOCIATE MEMBERS shall be persons not under 21 years of age engaged in work connected with the practice or science of mining, but not in the opinion of the Council in sufficiently important or responsible positions to qualify them for election as members.

4. STUDENTS shall be persons not under 16 nor over 25 years of age. They must be either students of some recognized School of Mining or occupy some subordinate position connected with the practice or science of mining or metallurgy.

IV.—ELECTION OF MEMBERS.

1. Any person desirous of becoming a Member or Associate Member shall be nominated by not less than three Members or Associate Members, provided that one of the nominators certifies to personal knowledge of the candidate's qualifications and suitability and that one at least is a Member.

2. Each person desirous of becoming a Student shall furnish the Council with satisfactory evidence of his connection with mining, and, if approved by the Council, shall thereupon be admitted by the Council; provided that the Council may, after due enquiry, remove any Student from membership.

3. Each nomination of a candidate as Member or Associate Member shall set out distinctly the name, usual residence, and full qualification of the person nominated, shall bear the written consent of the candidate to such nomination, and shall be forwarded to the Secretary, who shall forthwith submit it to the Council. The Council shall determine whether the qualifications of a candidate are sufficient according to the Rules and if approved, may submit the nomination to Members and Associate Members for confidential report. The Council may elect the candidate to the class for which he is eligible provided that, in the event of a candidate's nomination having been submitted to Members and Associate Members for confidential report, the Council shall not proceed with his election for six weeks after such submission.

7. Associate Members desirous of being transferred to the class of Members must make application for transfer to the Council. Such application must be signed by at least three Members and must give fully the evidence upon which the applicant relies.

8. Students may not continue to be connected with the Institute after attaining the age of 25 years. They may make application for admission as Associate Members on attaining the age of 21 years, or as Members on attaining the age of 25 years.

VI.—SUBSCRIPTION.

1. On election each Member shall pay an Entrance Fee of Two Guineas and each Associate Member One Guinea and a Half; on transfer from Associate Member to Member, each Associate Member shall pay a fee of Half-a-Guinea.

2. Each Member shall pay an Annual Subscription of Two Guineas, each Associate Member, One Guinea and a Half; and each Student, Half-a-Guinea.

PROCEEDINGS

OF THE

AUSTRALASIAN

Institute of Mining & Metallurgy.

NEW SERIES.

No. 34.

EDITED BY THE SECRETARY.

This Institute is not responsible, as a body, for the facts and opinions advanced in any of its publications.

30th JUNE, 1919.

PUBLISHED QUARTERLY BY THE AUSTRALASIAN INSTITUTE OF MINING & METALLURGY, MELBOURNE.

Australasian Institute of Mining and Metallurgy.

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George C. Klug, W.A.

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James Hebbard	New South Wales
James Horsburgh	Queensland
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D. L. Stirling, Melbourne, Vic.

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South Australia	Professor R. W. Chapman, Adelaide.
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Western Australia	F. W. R. Godden, Kalgoorlie.
New Zealand	D. B. Waters, Dunedin.
Tasmania	Russell M. Murray, Mount Lyell.
North Queensland	Murray Russell, Brisbane.

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Kalgoorlie	F. W. R. Godden, Ivanhoe Gold Corporation, Boulder, W.A.
Broken Hill	J. M. Bridge, c/o Zinc Corporation Ltd., Broken Hill, N.S.W.
Mount Morgan	B. G. Patterson, Mount Morgan, Q.

The Executive Committee consists of all Members of the Council residing, or for the time being, in Melbourne.

Head Office:

48 Queen Street, Melbourne, Victoria.

Institute Matters.

CONTENTS.

	Page
MINUTES OF MEETINGS—	
Of the Institute	xlix
Of the Executive Committee	l
NOTICES	lii
PUBLICATIONS—Added to Library	lviii
RECENT ARTICLES—On Mining Matters	lx

MINUTES OF MEETINGS.

OF THE INSTITUTE.

(Special Meeting.)

MELBOURNE, 6TH JUNE, 1919.

IN THE INSTITUTE ROOMS, 48 QUEEN STREET, AT 1 P.M.

Mr. W. E. Wainwright (President) in the chair.

The Secretary read the notice convening the meeting.

The Scrutineers appointed by the chairman to examine ballots on the following questions:—

(1) "That the Australasian Institute of Mining Engineers become a Foundation Society and Section of the proposed Institution of Engineers of Australia (refer to preamble and clauses 3 to 8 of the proposed constitution).

(2) That Rule 1 be altered to read—"The Institute shall be called the Australasian Institute of Mining and Metallurgy."

reported that in regard to No. 1 the vote was almost unanimously "No" and in regard to No. 2 very decidedly "Yes."

Of the Executive Committee.

(Summary)

April 8th, 1919—1 p.m.

The Secretary's report was submitted, and accounts to the amount of £42 passed for payment.

It was reported that Francis P. Bray (member) had been killed in action and that Dr. Rossiter W. Raymond (Hon. member) had died in December, 1918. Letters of sympathy were directed to be forwarded to the relatives of the deceased members.

Appreciation was expressed at the donation by Mr. R. Slessor (member) of 68 Volumes of Proceedings of the Institution of Civil Engineers and 67 Volumes of Proceedings of the Institution of Mechanical Engineers.

The report of the Sub-Committee appointed at the special meeting of the Executive Committee on 13th March, to draft a circular to members *re* the proposed amalgamation of Engineering Associations was adopted.

Obituary notes concerning the late W. F. McBryde Broun (Associate member) were submitted by the Hon. Secretary, Mount Morgan Branch and referred to the Publication Committee.

Other routine business was transacted.

April 17th, 1919—1 p.m.

Letters from the Chairman and Secretary of the Provisional Council of the proposed Institution of Engineers of Australia forwarding 550 Copies of the final draft of the constitution of the Institution were submitted and directions given regarding replies thereto. Letters from members of Council in the various States were also submitted approving, in nearly every instance, of the circular letter which the Executive Committee had drafted for issue to members with the draft constitution and ballot papers.

May 20th, 1919—1 p.m.

The Secretary's report was submitted, and accounts to the amount of £265, including printing £196, were passed for payment.

The following were elected to the Institute :—Members—Messrs. Harold Beech, Archibald C. Julius and Alexander McIntosh Reid. Associate Members—Messrs. William Hart, Thomas Sampson, Thomas Henry Hooper and Leslie Gordon Klem.

Nominations of Messrs. Louis N. Stutterd for transfer from Associate Member to Member and of O. M. Williams as Associate Member were approved.

Suggestions from Mr. G. H. Blakemore (Life Member) in regard to increase of membership and extension of Local Committees were referred to a special Sub-Committee for report.

Resolved that a paragraph be inserted in the Proceedings directing the attention of members to the Java General Engineering Congress in May, 1920.

The report of the Finance Committee was submitted and adopted.

A report from the Secretary of the Kalgoorlie branch showed that the prospects for holding the First Ordinary Meeting, 1919, at Kalgoorlie were not at present such as to warrant the meeting being held there.

JUNE 6TH, 1919—1.15 P.M.

The memorandum of the special Sub-Committee appointed to report on Mr. G. H. Blakemore's suggestions *re* the extension of Local Committees and introducing new members was submitted and approved. The report was in favor of the suggestions being carried into effect.

A report was also submitted of the result of ballot of members on the proposed amalgamation of Engineering Associations and on the change of name of the Institute. The report showed that members were against the proposed amalgamation and in favor of the change of name to the Australasian Institute of Mining and Metallurgy.

NOTICES.

The rooms of the Institute are open from 9 A.M. to 5 P.M. daily, except Sundays and Public Holidays.

CHANGE OF NAME.

As announced by circular No. 3, 1919, members decided by ballot on 6th June, that the name of the Institute be altered to the "Australasian Institute of Mining and Metallurgy." The Institute will accordingly be known by that name in future. The title is considered a much more comprehensive and suitable one and covers all branches connected with mining and metallurgy.

MEMBERSHIP.

Since the last issue of Proceedings the following have been admitted to the Institute :—

Members.

Names and Addresses.

BEECH, HAROLD, Sons of Gwalia Mine, Gwalia, W.A.

JULIUS, ARCHIBALD COWPER, C.S.A. Mine, Cobar, N.S.W.

REID, ALEXANDER MCINTOSH, Geological Survey Office, Launceston, Tasmania.

Associate Members.

HART, WILLIAM, Mount Lyell M. & R. Co., Gormanston, Tas.

HOOPER, THOMAS HENRY, Butlers Tin Mine, Torrington, N.S.W.

KLEM, LESLIE GORDON, Noumea, New Caledonia.

SAMPSON, THOMAS, c/o Benson Bros., Liverpool Street, Sydney, N.S.W.

Applications for admission to the Institute have been received from the following :—

Transfer from Associate Member to Member—Louis Norman Stutterd, Marranboy, Northern Territory. As Associate Member —Oswald Maurice Williams, Thermo-Electric Ore Reduction Corporation Ltd., Wolfram, North Queensland. These names are now submitted to members for confidential report.

EXTENSION OF SCOPE.

The Council has decided, now that the war is over, to extend the establishment of Local Committees to each Capital City and to mining and metallurgical centres where such Committees are not already established. Circular No. 3 invited the assistance of members in forming such Committees and in recruiting new members from the coal-mining areas and the iron and steel industry. Expansion in these directions should add greatly to the importance and status of the Institute.

PROPOSED AMALGAMATION OF ENGINEERING ASSOCIATIONS.

An announcement has already been made of the result of the ballot on the proposal that the Australasian Institute of Mining Engineers become a section of the proposed Institution of Engineers of Australia. Scrutiny of the ballot papers showed that members almost unanimously decided against the proposal.

JAVA GENERAL ENGINEERING CONGRESS, 1920.

A General Engineering Congress is to be held in Batavia, Java, from the 8th to the 15th May, 1920 inclusive, the subjects for discussion thereat being:—*Communication:* Railways, tramways, telegraphy, harbors, steamers and vessels generally. *Irrigation:* Drainage, waterworks, etc. *Roads and Bridges. Town Planning:* Architecture, etc. *Production of Energy:* Including steam, electricity and water power. *Industries:* Iron works, factories and agricultural industries. *Mining and Geology:* and such allied subjects as technical education, labor, building materials, aerial navigation. Engineers from South and East Africa, British India, Phillipines, Western America, Japan and China, as well as from Australia, have been invited to co-operate. The main idea is to influence the technical development of Eastern Asia. In the parent country (Holland) a committee has been created with the object of giving whatever co-operation is possible. The Governor General of Netherlands India, Earl J. Van Limburg Stirum, has accepted the post of Patron of the Congress and promised his Government's support. A broad appeal is being made to intending visitors from other countries to assist in extending the newly formed technical relations between their countries and Java. There are common needs being felt amongst the leading engineers of various

countries to solve many technical problems, and the intention of the Batavia Congres is to assist in this direction. It may be anticipated that by April, 1920, the steamer service to Java will be running under normal conditions, and indeed that new routes to the Island will have been opened up, so that those who are desirous of attending the Congress, and incidentally visiting this very interesting Island, may hope to look forward to doing so without insurmountable difficulty.

PUBLICATIONS.

Papers appearing in this number are :—

Tapping Water by Diamond Drill Holes (with 1 Plate and 1 Fig.). By Edmund B. Dow.

Isometric Mine Plans (with 9 Figs.). By H. Edward Clayton.

Ore-Treatment Plant and Treatment Operations at the Edna May Gold Mining Company, N.L., Westonia, W.A. (with 1 Fig.). By M. T. Williams.

Notes on Cornish Tin Mining. By the late W. F. M'Bryde Brown.

MOVEMENTS OF MEMBERS.

G. I. Adcock (Capt.) was in March last, education officer attached to the 2nd Australian Tunnelling Co. in France.

Ralph N. Beckwith, who was at the Mount Gunson Mine for six years as superintendent, has been appointed by the Sulphide Corporation Ltd. to look after its interests at Port Pirie.

R. H. Crozier, recently with the Hampden Cloncurry Co., sailed for Burma on 27th June, under engagement by the Burma Mines Ltd., Namtu.

G. A. Denny is shortly leaving Johannesburg for London.

H. Warlow Davies (Lieut.) returned to Australia from Active Service, in June, 1919. He is now in Melbourne on the staff of the Electrolytic Zinc Co. of Australia Ltd.

E. H. Fraser (Capt.) who joined the Engineers Field Co. in 1915, was, prior to serving in France, through the Gallipoli campaign. He returned to Australia in March, 1919. Before enlisting he was on the Broken Hill Field.

A. H. Kelly (Cpl.) who was on Active Service with the 3rd Light Horse Regiment in Palestine, has returned to Australia and has accepted an appointment at the Broken Hill Proprietary Steel Works, Newcastle, N.S.W.

Keith B. Lewis is doing a course at the Royal School of Mines, London. Prior to his enlistment for Active Service early in the war, he was with the Country Roads Board, Melbourne.

D. C. Mackenzie (Lieut.) who enlisted in the 2nd Tunnelling Co. in December, 1915, returned from the front on 5th February, 1919.

Kenneth A. Mickle (Capt.), D.S.O. returned from Active Service early in the year suffering badly from the effects of gas. He was, on his return, for some months in a private hospital, but has recently been taken to his home in St. Kilda. Notice of Capt. Mickle's distinguished service at the front was published in a previous issue of Proceedings.

Arthur H. P. Moline is now General Manager of the Bendigo Amalgamated Goldfields N.L., Bendigo, Vic.

Walter J. Rose (Capt.), M.C. is now on the staff of the Electrolytic Zinc Co. of Australia in Melbourne. He was on Active Service for three years and at the termination of the war returned to Australia via America.

C. N. Ross, who has been in England on war work, is now at the University of Queensland.

Malcolm B. Scott has severed his connection as engineer of the Kalgurli G.M., Fimiston, W.A. He joined the staff of the Kalgurli G.M. as assistant engineer in 1904 and was promoted to engineer in 1909.

W. Shellshear, recently with the Burma Mines Ltd., Namtu, Burma, is leaving for America in July. His temporary address will be c/o Thomas Cook and Son, San Francisco.

Robert Slessor of Sydney, sailed in May for Hong Kong where he will occupy the position of consulting engineer.

H. P. Wallmann (Lieut.) who left Australia with the 3rd Tunnelling Co. in June, 1916, returned after three years Active Service, on June 8th, 1919, and is now in Melbourne.

Honors Won.

A. G. Campbell has been awarded the D.S.O.

Captain Monckton Bowes Kelly has been decorated with the Croix de Guerre by the President of the French Republic for conspicuous services rendered.

C. S. Kneebone won the Military Medal near Mont St. Quentin on 31st August, 1918. He left Australia on Active Service on 25th March, 1916 with the 27th Battalion. In June, 1918, he was attached to the 7th Field Engineers. He was at Pozieres, Flers, Ypres, Villers Bretonneux and Mont St. Quentin (Peronne). He returned to his home at Woodville, S.A. on 13th April, 1919.

R. D. Southon has been decorated with the Military Cross.

Captain O. H. Woodward, M.C. and three bars, 1st Tunnelling Co., enlisted in November, 1915 and returned to Australia on 15th May, 1919. He gained his commission in December, 1915, and his captaincy in October the following year, when he was in command of the 1st Tunnelling Company. The Military Cross was awarded in July, 1916, for having succeeded, under difficult circumstances, and after repeated attempts, in blowing up a house 120 yards from the trenches, which was frequently used by the enemy snipers. His bravery and initiative have added three bars to the Military Cross. Captain Woodward was with the Mount Morgan Co. before enlisting.

Honor Roll.

Harry M. Dean's name has to be added to the list of those names appearing in the Honor Roll published in Proceedings No. 33.

Killed in Action.

Word has been received that Harvey S. Warde, who enlisted in the 36th Machine Gun Co., A.I.F., was killed in action. Mr. Warde was for a number of years Inspector of Mines for the Central District, Queensland.

Wilfred P. Avery has been reported killed in action in France. Prior to enlisting in 1915, he was at the Klong Sa Mine, Tammarat Mining Syndicate, Bandon, Siam.

Andrew Getty, late Assistant Surveyor on the Ivanhoe Gold Corporation has been reported killed on Active Service. He was in hospital 50 miles behind the lines when the hospital was struck by an aeroplane bomb. He was an associate of the Western Australian School of Mines and would have gone far in his profession had he lived.

OBITUARY.

Frederick Henry Evans (member) manager of the Sulphide Corporation's Works at Cockle Creek, N.S.W., died from pneumonic influenza at the above works on Saturday 21st June, 1919 after three days illness. The deceased member was 45 years of age and was born in Richmond, England, but came to New South Wales when five years old. He was educated at the Sydney Grammar School and at the age of 22 years commenced work with the Sulphide Corporation as a metallurgical chemist. He became assistant to Mr. A. E. Savage (the first manager of the works) when smelting works were commenced and after a period he took full charge of operations in 1914, with his brother, Mr. H. A. Evans, as works manager. He leaves a wife and four children. Mr. Evans was a man of keen insight and clear, quick judgment, and the trust imposed upon him by the Sulphide Corporation was a compliment to his standing in the metallurgical profession. On the occasion of the Institute visit to the Cockle Creek Works in August, 1918 he was deputed by the General Manager, Mr. C. F. Courtney, to make arrangements for the visit, and those who had the privilege of attending will long remember how well every detail was arranged for the inspection of the works and entertainment of members. His consideration for the staff and employés at Cockle Creek greatly endeared him to them and his sudden death in the prime of manhood was a great blow to all who knew him and a heavy loss to the metallurgical profession.

LIST OF PUBLICATIONS ADDED TO THE LIBRARY

From 31st March, 1919 to 30th June, 1919.

Australian Mining and Engineering Review	monthly -	Melbourne
Industrial Australian & Mining Standard -	-	Melbourne
Engineering and Mining Journal - -	weekly -	New York
Iron and Coal Trades Review - -	weekly -	London
Mining and Engineering World - -	weekly -	Chicago
Mining Magazine - - -	monthly -	London
Indian Engineering - - -	weekly -	Calcutta
Chemical News - - - -	weekly -	London
South African Engineering - -	monthly -	London
Journal of Industrial and Engineering Chemistry - - -	monthly -	Easton, Pa.
Society of Chemical Industry : Journal -	bi-monthly	London
Chemical, Metallurgical and Mining Society of South Africa : Journal - -	monthly -	Johannesburg
Franklin Institute : Journal - -	bi-monthly	Philadelphia
Institution of Mechanical Engineers : Journal	monthly	London
Chamber of Mines of Western Australia : Journal - - - -	monthly -	Kalgoorlie
The West Australian Mining, Building and Engineering Journal - - -	weekly -	Perth
Queensland Department of Mines : Government Mining Journal - -	monthly -	Brisbane
Transvaal Chamber of Mines : Monthly Analysis of Gold Production	-	Johannesburg
Rhodesia Chamber of Mines : Report of Executive - - -	monthly -	Bulawayo
Department of Mines, Victoria : Geological Survey, Bulletins, Nos. 39 and 41		
Department of Mines, South Australia : Mining Review (No. 29) for Half-Year ended Dec. 31, 1918		Adelaide
Department of Mines, Western Australia : Geological Survey, Bulletin, No. 77 - -		Perth
Institution of Mining and Metallurgy : Bulletins, Nos. 173-175 - - -		London

Institute of Chemistry of Great Britain and Ireland :
Proceedings, 1918, Part 4 ; 1919, Part 1 - London
Institution of Mining Engineers :
Transactions, Vol. LVI., Parts 3 and 4 - London
Annales des Mines :
Vol. VII., Pages 262-335 - - Paris
Société des Ingenieurs Civils de France :
Bulletin, Nov. and Dec , 1918 - - Paris
Sveriges Geologistsa Undersokning :
Arsbok, 1915 and 1916
Ser. Ca. Nos. 14-16 - - - - Stockholm
Geological Institution of the University of Upsala :
Bulletin, Vol. XIII., No. 2, 1916 ; XIV. and XV. Upsala
Societa Geologica Italiano :
Bulletin, Vol. XXXVII. (1918), No. 1 - Rome
Canadian Mining Institute: Transactions, Vol. XXI. Montreal
Bureau of Mines, Canada :
Annual Report, Vol. XXVII., Part 1, 1918 - Toronto
Department of Mines, Canada :
Geological Survey—Summary Report, 1917 A and 1917 F
Memoir, No. 96, Snooke and Duncan Map Areas, Vancouver Island - - Ottawa
American Institute of Mining and Metallurgical Engineers :
Bulletins. Nos. 147 and 148 - - - New York
American Society of Civil Engineers :
Transactions, Vol. LXXXII., 1918 - - New York
California State Mining Bureau : Bulletin, No. 78 - Sacramento
Geological Survey of Alabama :
Bulletin, No. 17—Water Powers of Alabama
Bulletin, No. 18—Preliminary Report on the Crystalline and other Marbles of Alabama Alabama
Secretoria de Industria Y Comercio :
Bulletin, Dept. of Mines, Vol. V., Nos. 3 and 4 - Mexico
Cuerpo de Ingenieros de Minas, Peru :
Bulletins, Nos. 89-95
Memoirs, Vol. XX., Nos. 6 and 7 - - Lima

RECENT ARTICLES ON MINING MATTERS.

(31st March, 1919, to 30th June, 1919).

NOTE.—*This list is prepared for the purpose of placing before members the titles of the more important papers appearing in the usual publications concerned with mining engineering, metallurgy, &c., due regard being had to Australasian requirements.*

LIST OF PUBLICATIONS.

References are given by the number prefixed to each publication in the attached list. Wk., weekly; mth., monthly.

(1) *The Industrial Australian & Mining Standard*, Melbourne, Victoria, wk., 6d.

(2) *The Queensland Government Mining Journal*, Brisbane, mth., 6d.

(3) *Metallurgical and Chemical Engineering*, New York, mth., 25c.

(4) *The Mining Journal*, London, E.C., wk., 6d.

(5) *Mining and Engineering World*, Chicago, wk., 10c.

(6) *The Engineering and Mining Journal*, New York, wk., 15c.

(7) *The Colliery Engineer*, Scranton, Pa., U.S.A., mth., 20c.

(8) *Mining and Scientific Press*, San Francisco, Cal., wk., 10c.

(9) *Annales des Mines*, Paris, France, mth.

(10) *Publications*, Department of Mines, Melbourne, Victoria.

(11) *Publications*, Department of Mines, Sydney, New South Wales.

(12) *Publications*, Department of Mines, Adelaide, South Australia.

(13) *Publications*, Department of Mines, Brisbane, Queensland.

(14) *Publications*, Department of Mines, Perth, Western Australia.

(15) *Publications*, Department of Mines, Hobart, Tasmania.

(16) *Publications*, Geological Survey, Canada, Ottawa, Ontario.

(17) *Publications*, Bureau of Mines, Toronto, Ontario.

(18) *Publications*, Geological Survey of India, Calcutta.

(19) *Publications*, Geological Survey, U.S.A., Washington.

(20) *Publications*, Geological Survey, Alabama, Montgomery, Ala.

(21) *Publications*, California State Mining Bureau, Sacramento, Cal.

(22) *Reports* Aust. Assoc. Adv. Science, Sydney, New South Wales.

(23) *Transactions and Proceedings*, New Zealand Inst., Wellington, New Zealand.

(24) *Quarterly Journal*, Geological Society, London.

(25) *Transactions*, Inst. Mining and Metallurgy, London, E.C.

(26) *Transactions*, Inst. Min. Eng., London.

(27) *Journal*, Canadian Mining Inst., Ottawa, Ontario.

(28) *Journal*, Chem., Min., and Met. Soc. of S.A., Johannesburg, Transvaal.

(29) *Transactions*, Am. Inst. of Min. & Met. Eng. New York City.

(30) *Proceedings*, Colorado Scientific Soc., Denver, Col.

(31) *Journal*, Franklin Inst., Philadelphia, Pa.

(32) *Australian Mining and Engineering Review*, Melbourne, Vic., mth., 6d.

(33) *Transactions*, Am. Soc. C.E., New York City.

(34) *Bulletins*, Société des Ingénieurs Civils, Paris.

(35) *Mining Magazine*, 819 Salisbury House, London, E.C., mth., 1s.

(36) *Publications*, Iron and Steel Institute, London.

(37) *Proceedings*, Inst. of Mech. Eng., London.

(38) *Publications*, Field Columbian Museum, Chicago, U.S.A.

(39) *Journal*, Mining Society of Nova Scotia, Halifax, N.S.

(40) *Transactions*, Mining and Geological Institute of India, Calcutta.

(41) *Publications*, Department of Mines, Wellington, N.Z.

(42) *Journal*, Chamber of Mines of West Australia, Perth.

(43) *Journal of Industrial and Engineering Chemistry*, Easton, Pa.

(44) *Proceedings*, Geologists' Association, London.

LIST OF ARTICLES.

GEOLOGICAL.

The Origin of the Gold Deposits in the Canadian Pre-Cambrian. R. C. Wallace. (27) Vol. XXI.
The Formation of Ore-Bodies. J. D. Kendall. (27) Vol. XXI.
Mesozoic Period of Mineralization in British Columbia. S. J. Schofield.
Sources of Indnstrial Potash in Western Anstralia. E. S. Simpson. (14) Bull. Geol. Survey, No. 77.

MECHANICAL.

Standardization of Mine Cars in Metal Mines. R. W. Raymond. (6) Feb. 1, 1919.
Lubrication of Air Compressors. H. V. Conrad. (6) March 1, 1919.
The Compound Air Lift. A. W. Allen. (6) March 8, 1919.
Notes on Economies in Hand-Drill Steel. H. A. Read. (28) March, 1919.

METALLURGICAL.

Manufacture of Ferro-Molybdenum in Canada. J. W. Evans. (27) Vol. XXI.
The Smelting and Refining of Silver Ore from the Cobalt Area; and the Production and Use of Stellite. S. B. Wright. (27) Vol. XXI.
The Estimation of Oxygen in Working Cyanide Solutions: Discussion. H. A. White. (28) Feb., 1919, and March, 1919.
Chemical Engineering. J. A. Wilkinson. (28) March, 1919.
Concentration at the British Broken Hill. G. C. Klug. (35) Jan., 1919.
Froth Flotation. V. F. Stanley Low. (35) April, 1919.
Notes on Cyaniding. W. B. Blyth. (35) April, 1919.
Giew Mill Test: The Elutriation of the Crushed Products. S. J. Truscott. (25) Bull. No. 173.
Slime Treatment on Cornish Frames: Supplements. S. J. Truscott. (25) Bull. No. 173. Discussion: Bull. No. 174.
A Comparison of Concentration Results, with Special Reference to the Cornish Method of Concentrating Cassiterite. E. Edser. (25) Bull. No. 173. Discussion: Bull. No. 174.
The Volatilization of Gold. Sir T. K. Rose. (25) Bull. No. 174. Discussion: Bull. No. 175.
The Action of Reducing Gases on Hot Solid Copper: Discussion. N. B. Pilling. (29) Bull. No. 147.
The Ruck Zinc-Distilling Furnace. (6) Feb. 15, 1919.
Melting Silver, Nickel, and Bronze Alloys by Electricity. (6) Feb. 15, 1919.
A New Zinc-Lead Mill in Colorado. (6) March 1, 1919.
Automatic Ore-Pulp Sampler. (6) March 1, 1919.
International Nickel Company's Refining Works at Port Colborne, Ontario. W. L. Wotherspoon. (6) March 8, 1919.
Effect of Air in Cyanidation. N. S. Keith. (6) March 22, 1919.
Re-treating Zinc Tailings in Wisconsin. W. F. Boericke. (6) March 22, 1919.
Metallurgy of the Oklahoma–Kansas District. R. W. Johnston and C. E. Heinz. (6) March 29, 1919.
The Problem of Treating Impure Manganese Ores. E. Newton. (6) March 29, 1919.
Sampling Practice at Independence Mill. C. T. Rice. (6) April 12, 1919.
Estimating Screen Efficiency. W. O. Borcherdt. (6) April 12, 1919.
Air Volume Regulation in Smelting and Refining Furnaces. C. H. Smoot. (6) April 12, 1919.
Iron-Ore Concentration on the Mesabi Range. F. A. Kennedy. (6) April 19, 1919.
Ampere Efficiency in Copper Refining. M. H. Merriss. (6) April 26, 1919.
Recent Improvements in Sintering Equipment and Practice. (6) April 26, 1919
Froth Removal from Flotation Cells. C. T. Rice. (6) April 26, 1919.
The Groch Flotation Machine. F. O. Groch and W. E. Simpson. (27) Vol. XXI.

MINING.

A Study of Shovelling as Applied to Mining. G. T. Harley. (6) Serial commenced March 15, 1919.
Tunnel Driving at Copper Mountain. O. Lachmund. (6) March 29, 1919.
Mining Methods at the Worthington Mine, with Notes on Underground Contract System. R. N. Palmer. (27) Vol. XXI.

Application of the Theory of Probability in the Deterioration of Ore Reserves. G. A. Watermeyer. (28) Jan., 1919. Discussion: March 1919, April, 1919.

Cementation Process Applied to Mining (Francois System). A. H. Krynauw. Discussion. (28) Feb., 1919.

Further Notes on Sand-filling of Mines. C. H. Greathead. Reply to Discussion. (28) Feb., 1919.

The Technique of Diamond Drilling. J. A. MacVicar. (35) Jan., 1919.

Cobar Stopes Measurement Methods. W. S. Curteis. (25) Bull. No. 174. Discussion: Bull. No. 175.

MISCELLANEOUS.

Operations of the Burma Mines Ltd. A. B. Parsons. (6) Feb. 8, 1919.

American Gold Committee's Finding. (6) Feb. 8, 1919.

Concreting Prospect Drill Holes. R. H. Poston. (6) Feb. 15, 1919.

Examining and Developing the Mine Prospect. H. T. Curran. (6) Feb. 22, 1919.

Sampling of Dust in Mine Air. (6) March 1, 1919.

Calibration of Base-Metal Thermocouples. C. S. Crouse. (6) March 8, 1919.

Uses and Limitations of Respirators, Gas Masks, and Oxygen Apparatus. (6) March 15, 1919.

Neutralizing Acid Mine Water. (6) March 15, 1919.

Rise in Cost of Zinc Mining in Wisconsin. W. F. Boericke. (6) March 29, 1919.

Army Gas Masks in Sulphur-Dioxide Atmospheres. A. C. Fieldner and S. H. Katz.

"The Whitley Scheme"—A Step Towards Democratizing Industrial Relations. C. V. Corless. (27) Vol. XXI.

Waste of Coal in Canada. W. J. Dick. (27) Vol. XXI.

Mine Fires: their Origin, Danger, and Control. A. J. Tonge. (27) Vol. XXI.

Notes on the Advantages of Efficient Coal Washing as Reflected in the Manufacture of Iron and Steel. W. H. Graham. (27) Vol. XXI.

Distillation of Coal. F. E. Lucas. (27) Vol. XXI.

Electrical Precipitation of Tar Fog. J. G. Davidson. (27) Vol. XXI.

The Geologist and the Development of Our Oilfields. M. Y. Williams. (27) Vol. XXI.

The Estimation of Injurious Dust in Mine Air by the Kotze Konimeter. J. Innes. (28) Feb. 1919.

The Effects of Dust Inhalation. J. S. Haldane: Discussion. (28) March, 1919.

Tungsten and the War. J. L. F. Vogel. (35) Jan., 1919.

The Gold Problem: Report of the Government Gold Production Committee. (35) Jan., 1919.

The Ore Minerals of Tavoy. J. M. Campbell. (35) Feb., 1919.

The Northampton Lead-Mining District, Western Australia. C. M. Harris. (35) March, 1919.

A Small Hydro-Electric Installation. E. P. Hollis. (35) March, 1919.

Australian Iron Ore Resources. (35) March, 1919.

Methods of Surveying Stope-Filling. E. F. Harris. (35) April, 1919.

The Long Tunnel and Adjacent Mines, Walhalla. W. Baragwanath. (10) Geol. Survey Bull. No. 39.

The Confidence Group of Mines, Bendigo. H. S. Whitelaw. (10) Geol. Survey Bull. No. 41.

The Giblin Tin Lode of Tasmania. C. W. Gudgeon. (25) Bull. No. 173.

The Work of the Miner on the Western Front, 1915–1918. H. S. Ball. (25) Bull. No. 175.

Digest of the First Report of the Mine Rescue-Apparatus Research Committee. D. Penman. (26) Trans., Vol. LVI., Part 4.

PROCEEDINGS

OF THE

AUSTRALASIAN

Institute of Mining & Metallurgy.

NEW SERIES.

No. 35.

EDITED BY THE SECRETARY.

This Institute is not responsible, as a body, for the facts and opinions advanced in any of its publications.

30th SEPTEMBER, 1919.

PUBLISHED QUARTERLY BY THE AUSTRALASIAN INSTITUTE OF MINING & METALLURGY, MELBOURNE.

Australasian Institute of Mining and Metallurgy.

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North Queensland	MURRAY RUSSELL, Brisbane.

BRANCH SECRETARIES:

Kalgoorlie	F. W. R. GODDEN, Ivanhoe Gold Corporation, Boulder, W.A.
Broken Hill	J. M. BRIDGE, c/o Zinc Corporation Ltd., Broken Hill, N.S.W.
Mount Morgan	B. G. PATTERSON, Mount Morgan, Q.

The Executive Committee consists of all Members of the Council residing, or for the time being, in Melbourne.

Head Office:

48 QUEEN STREET, MELBOURNE, VICTORIA.

lx'''

Institute Matters.

CONTENTS.

	Page
Minutes of Meetings—	
Of the Executive Committee	lxiii
Notices	lxvii
Reports of Branches	lxxi
Publications—Added to Library	lxxii
Recent Articles—On Mining Matters	lxxiv

MINUTES OF MEETINGS.

Of the Executive Committee.

(Summary)

July 21st, 1919—1 p.m.

Accounts to the amount of £125, including Publications £57, were passed for payment.

Nominations of Messrs. W. H. Bowater and F. T. Kerr as Associate Members were deferred for enquiry.

The following paper was referred to the Publication Committee:—"Notes on the S. & M. Mine, and on Treatment of Bismuth, Tin and Wolfram Ores," by Wm. E. Hitchcock and J. R. Pound.

A donation from Messrs. Chapman & Hall of a copy of "Mining Engineers' Handbook," by Robert Peele was reported.

Resolved that, members of Council be requested to express their opinion as to whether or not the Institute should recommend the exclusive use of the Metric System throughout the British Empire.

A letter was submitted from Messrs. F. Danvers Power and William Poole, accompanied by a circular issued to all members

of the Institute on the subject of the re-organisation of the Institute, etc., and it was resolved that a Special Meeting of the Executive Committee be convened at an early date to decide what action should be taken in regard to the circular. The opinion was expressed by members of the Committee and in letters received from members of the Institute that, in the best interest of the Institute as a body, any important constructive suggestions should, in the first instance, be submitted to the Council.

Other routine business was transacted.

August 4th, 1919—1 p.m. (Special Meeting.)

It was resolved that a Special General Meeting of members be held in Melbourne, commencing on 27th October, 1919, for the purpose of considering the present basis of the Institute, and of extending its scope and activities (preliminary steps for extending the scope of the Institute were indicated in Circular No. 3, dated 30th June, 1919); members unable to attend to be invited to forward their suggestions in writing, when same will be considered together with those on pages 7 and 8 of the Circular recently issued to members by Messrs. Power and Poole.

As it was not found practicable to hold the usual Excursion Meeting this year, it was resolved that the First Ordinary Meeting, 1919, be held in Melbourne immediately after the Special Meeting, when papers on industrial and technical subjects will be read and discussed.

It was decided that notices of both Meetings be issued immediately and that a fuller programme be sent out later.

It was also resolved that Branches and Centres be particularly invited to send delegates to the Special Meeting.

August 26th, 1919—1 p.m.

The Secretary's report was submitted, and accounts to the amount of £48, including printing £32, were passed for payment.

Letters were submitted from several members of Council favoring the introduction of the Metric System. Further consideration was deferred pending receipt of other replies.

Correspondence on the subject of the extension of Local Committees was received.

A report from the Broken Hill Branch was submitted, also recommendations from the Branch in regard to certification of Mining Managers. Resolved that an effort be made to modify the requirements by the N.S.W. Board of Examiners, whereby 18 months' manual work underground is a condition prior to examination. The terms of a letter to the Minister for Mines were agreed upon. It was also resolved that steps be taken to secure uniformity in all the States and New Zealand, so that a certificate from any one State would hold good in the others. It was also decided that the matter be discussed at the First Ordinary Meeting in October.

In order to ensure representation of the various centres at the Special and First Ordinary Meetings in October, it was resolved that Branch Secretaries and Local Correspondents be asked to arrange to send a delegate.

Special Committees were appointed .—

(1) To prepare a scheme of re-organisation to be circulated before the Special Meeting.

(2) To arrange the Programme for the Special and Ordinary Meetings.

(3) To secure papers on industrial subjects and arrange discussion thereon.

Other routine business was transacted.

October, 2nd, 1919 (Special Meeting).

The Draft Constitution prepared by the Special Sub-Committee was submitted and it was resolved :—

(1) "That the draft suggestions of the Sub-Committee be printed, circulated and submitted to the Special General Meeting on 27th October, convened for the purpose of considering the present basis of the Institute and discussing ways and means for extending the scope and activities."

(2) "That the draft constitution as amended at the Special Meeting in October be subsequently submitted to members for their further consideration and finally dealt with at a Special General Meeting on a date to be arranged, not less than three months from 27th October, 1919."

(3) "That a Committee of the whole of the Council and Mr. J. M. Bridge be appointed in charge of the matter of the draft constitution."

Consideration was given to a communication from the Sydney Committee regarding a proposed amendment to the Local Government Act affecting the method of taxation of metalliferous mines and the conclusion was arrived at that the retention of the rating Clause, as set out in the Act of 1906, would be preferable to a complete alteration of the incidence of taxation with all its difficulties of interpretation.

It was resolved that the Annual Meeting be held on Friday, 30th January, 1920, at 1 p.m.

NOTICES.

The rooms of the Institute are open from 9 A.M. to 5 P.M. daily, except Sundays and Public Holidays.

MEMBERSHIP.

Application for admission to the Institute as Members have been received from the following:—William Henry Bowater, Thermo-Electric Ore Reduction Corporation, Wolfram, Queensland; Cyril John Emery, British Broken Hill Pty. Co., Broken Hill, N.S.W. and Joseph Miller, Story's Creek Tin Mining Syndicate, Avoca, Tasmania. These names are now submitted to members for confidential report.

EXTENSION OF SCOPE.

A Committee appointed by the Council has prepared a draft constitution to submit to the Special Meeting on 27th October, convened by Circular No. 4 for the purpose of considering the present basis of the Institute and discussing ways and means for extending its scope and activities. A copy of the draft constitution has already been forwarded for consideration by members. The draft as amended at the Special Meeting will be subsequently submitted to members for their further consideration, and finally dealt with by ballot at a Special General Meeting to be held not less than three months from 27th October, 1919. Suggestions and full discussion on this important matter are invited, both in respect to the original draft, and the amended copy when received.

FIRST ORDINARY MEETING, 1919.

As already notified the First Ordinary Meeting, 1919, will be held in Melbourne immediately after the Special Meeting, when papers on Industrial and Technical subjects will be presented. Members intending to present papers are requested to notify the Secretary as soon as possible.

ANNUAL MEETING, 1920.

The Annual Meeting, will be held at the rooms, 48 Queen Street, Melbourne, on Friday, 30th January, at 1 p.m. The business of the meeting will include the presentation of the Annual Report and Balance Sheet for 1919 and the election of officers to fill the annual vacancies. The officers retiring are—President, Mr. W. E. Wainwright; Vice-President, Professor R. W. Chapman; Councillors, Messrs. A. A. Boyd, James Hebbard, James Horsburgh, F. Danvers Power, Lindesay C. Clark, H. H. Schlapp and R. C. Sticht. Nominations to fill the vacancies thus occuring should reach the Secretary forty days before the Annual Meeting.

PUBLICATIONS.

Discussion is invited of the following paper appearing in this issue :—

Notes on the S. & M. Mine and on Treatment of Bismuth, Tin and Wolfram Ores. By Wm. E. Hitchcock and J. R. Pound.

MOVEMENTS OF MEMBERS.

G. I. Adcock (Capt.), until recently with the 2nd Australian Tunnelling Co. in France returned to Victoria on 4th September, 1919.

A. G. Campbell (Capt.), D.S.O. has returned to Victoria. He joined the 8th Battalion, A.I.F. and left Australia on 29th September, 1915. He was in Egypt from 25th October, 1915 to 25th March, 1916, and in France and Belgium from 1st April, 1916 to 19th February, 1919. Capt. Campbell was wounded three times—at Pozieres on 24th July, 1916, at Lagincourt on 22nd April, 1917, and also on 11th August, 1918. He was decorated with the D.S.O., and mentioned in despatches.

C. H. J. Clayton (Lieut.) returned to Australia on 31st May, 1919. He enlisted on the 3rd July, 1916, and was with the 1st Australian Tunnelling Co. in the Ypres salient in January, 1917. He took part in the blowing-up of Hill 60 on 7th June, 1917, and then moved to Messines and Wytschaete, making timber roads for the offensive of 31st July, 1919. He had a variety of

experience in railway and road work in different parts of Northern France and Belgium. Lieut. Clayton is now on the staff of the Zinc Corporation Ltd., Broken Hill.

R. J. Donaldson (Major), D.S.O., 11th Field Company of Engineers has returned from Active Service abroad. Previous to enlisting for service in the Army, Major Donaldson took a prominent part in mining work at Broken Hill. He occupied a position as chief surveyor on the Central mine.

Basil G. Dunstan who has been for some time engaged in war work with H. M. Factory, Queensferry, England, has returned to Australia.

Donald Lovat Fraser (Lieut.) has returned to Australia after five years Active Service. He enlisted in 1914, and went through the Gallipoli campaign, and for the remainder of the war served in France and Belgium. He received his commission on the field in France.

H. W. Gartrell (Lieut.) returned to Australia on 17th July, 1919. He was on Active Service, first with the 2nd Australian Tunnelling Co., then with 257th Co. Royal Engineers. During service, he had charge of a battalion of Portuguese, when his knowledge of Spanish, obtained some years ago, proved most useful.

J. J. Grierson, late of the Jumbunna Coal Co. (Vic.), has accepted the position of Construction Engineer to the South Australian Portland Cement Co., and is at present engaged in constructing four miles of overhead ropeway from Brighton to Regnella.

N. S. Kellie McCallum has returned after three years Active Service in France, and is now with the Edith Mining Co. Ltd., Deepwater, N.S.W.

OBITUARY.

Kenneth Aubrey Mickle (Capt.), D.S.O. died on 30th July, at 30 Marine Parade, St. Kilda, after a long illness from the effects of gas received in action in France. Capt. Mickle was the son of Clara and the late David Mickle and was 33 years of age. He was educated at Queen's College and, after qualifying as a Metallurgist, studied in research work at the Melbourne University

for three years. There he won the Grimwade prize and other distinctions. On the outbreak of war he was chief chemist at the Burma Mines Ltd., Upper Burma. He enlisted in England in the Royal Garrison Artillery and received a commission, being promoted to Captain for bravery in the field. He had command of the 9th Division Trench Mortar Brigade and was decorated with the Distinguished Service Order. He saw much fighting on the Somme and at Arras. His death cut short an exceptionally promising career and he leaves many friends to mourn their loss.

DONATION.

Mining Engineers' Handbook—published by Messrs. Chapman and Hall, 11 Henrietta Street, Covent Garden, London—contains 2375 pages, price £1 3/- net. Editor-in-Chief, Robert Peele, Professor of Mining Engineering in the School of Mines, Columbia University. This useful handbook is divided into 44 sections replete with illustrations, calculations, tables and formulæ. At the end of each section there is a bibliography. The editor has endeavoured to meet the demands, not only of engineers concerned with the development and management of mines, but also of the large number of those who have more to do with, and greater interest in, the construction details involved in the installation of plant. The book is a most useful one and has been highly commended.

REPORTS OF BRANCHES.

BROKEN HILL BRANCH.

The Hon. Secretary of the Broken Hill Branch (Mr. J. M. Bridge) advises that the Broken Hill Mining Managers' Association has made the handsome donation of £100 to the Branch to provide four prizes of £25 each for papers on (1) Wet Concentration ; (2) Flotation. The selection of subjects for prizes 3 and 4 is left to the discretion of the Branch.

At a meeting of the Branch, held on 19th September, F. L. Stillwell, D.Sc., delivered a lecture on "The Quartz Reefs of Bendigo." The lecture was illustrated with lantern views and was well attended.

A geological excursion to Euriowie under the direction of Mr. E. C. Andrews (Government Geologist, N.S.W.) and Dr. F. L. Stillwell has been arranged for 3rd, 4th and 5th October.

SYDNEY BRANCH.

At a meeting of Sydney members, held on 26th August, a local committee was appointed consisting of Messrs. A. A. Atkinson, G. H. Blakemore, F. A. Eastaugh, Wm. Poole, F. Danvers Power, A. E. Savage and J. D. Audley Smith.

LIST OF PUBLICATIONS ADDED TO THE LIBRARY

From 30th June, 1919 to 30th September, 1919.

Australian Mining and Engineering Review	monthly	Melbourne
Industrial Australian & Mining Standard		Melbourne
Engineering and Mining Journal	weekly	New York
Iron and Coal Trades Review	weekly	London
Mining and Engineering World	weekly	Chicago
Mining Magazine	monthly	London
Indian Engineering	weekly	Calcutta
Chemical News	weekly	London
South African Engineering	monthly	London
Journal of Industrial and Engineering Chemistry	monthly	Easton, Pa.
Society of Chemical Industry : Journal	bi-monthly	London
Chemical, Metallurgical and Mining Society of South Africa : Journal	monthly	Johannesburg
Franklin Institute : Journal	bi-monthly	Philadelphia
Institution of Mechanical Engineers : Journal	monthly	London
Chamber of Mines of Western Australia : Journal	quarterly	Kalgoorlie
The West Australian Mining, Building and Engineering Journal	weekly	Perth
Queensland Department of Mines : Government Mining Journal	monthly	Brisbane
Transvaal Chamber of Mines : Monthly Analysis of Gold Production		Johannesburg
Rhodesia Chamber of Mines : Report of Executive	monthly	Bulawayo
Institute of Science and Industry : Journal, Vol. I., Nos. 3-5		Melbourne
Royal Society of Victoria : Proceedings, Vol. XXXI., Part 2		Melbourne
Royal Society of New South Wales : Journal, Vol. LI., 1917		Sydney
University of Sydney : Calendar, 1919		Sydney

Queensland Department of Mines :
Annual Report, 1918
Geological Survey Publications, Nos. 262 and 263 Brisbane
Department of Mines, Western Australia :
Geological Survey Bulletin, No. 82 - - Perth
Department of Mines, Tasmania :
Geological Survey Bulletin, No. 29 - - Hobart
New Zealand Journal of Science and Technology :
Vol. II., Nos. 2, 4 and 5 - - - Wellington
Geological Society :
Quarterly Journal, Nos. 292-294 - - London
Institution of Mining and Metallurgy :
Bulletins, Nos. 176-178 - - - London
Institute of Chemistry of Great Britain and Ireland :
Proceedings, 1919, Part 2 - - - London
Institution of Mining Engineers :
Transactions, Vol. LVI., Part 5 - - London
Annales des Mines : Vol. VII., Pages 336-478 - Paris
Societa Geologica Italiano :
Bulletin, Vol. XXXVII. (1918), Part 1 - Rome
R. Accademia delle Scienze dell' Institute di Bologna :
Rendiconto, Vols. XVII., XVIII., XIX. and XX. Bologna
Geological Institution of the University of Upsala, Sweden :
Bulletin, Vol. XIII., No. 2, 1916 ; XIV. and XV. Upsala
Geological Survey of India :
Records, Vol. XLIX., Part 4 ; Vol. L., Part 1 - Calcutta
Mining and Geological Institute of India :
Transactions, Vol. XIII., Part 2
List of Members, 1919 - - - Calcutta
American Institute of Mining and Metallurgical Engineers :
Bulletins, Nos. 149-152 - - - New York
California State Mining Bureau : Bulletin, No. 84 - Sacramento
Secretoria de Industria Y Comercio :
Bulletin, Vol. VI., Nos. 5 and 6 - - Mexico

RECENT ARTICLES ON MINING MATTERS.

(30th June, 1919, to 30th September, 1919).

NOTE.—*This list is prepared for the purpose of placing before members the titles of the more important papers appearing in the usual publications concerned with mining engineering, metallurgy, &c., due regard being had to Australasian requirements.*

LIST OF PUBLICATIONS.

References are given by the number prefixed to each publication in the attached list. Wk., weekly; mth., monthly.

(1) *The Industrial Australian & Mining Standard*, Melbourne, Victoria, wk., 6d.

(2) *The Queensland Government Mining Journal*, Brisbane, mth., 6d.

(3) *Metallurgical and Chemical Engineering*, New York, mth., 25c.

(4) *The Mining Journal*, London, E.C., wk., 6d.

(5) *Mining and Engineering World*, Chicago, wk., 10c.

(6) *The Engineering and Mining Journal*, New York, wk., 15c.

(7) *The Colliery Engineer*, Scranton, Pa., U.S.A., mth., 20c.

(8) *Mining and Scientific Press*, San Francisco, Cal., wk., 10c.

(9) *Annales des Mines*, Paris, France, mth.

(10) *Publications*, Department of Mines, Melbourne, Victoria.

(11) *Publications*, Department of Mines, Sydney, New South Wales.

(12) *Publications*, Department of Mines, Adelaide, South Australia.

(13) *Publications*, Department of Mines, Brisbane, Queensland.

(14) *Publications*, Department of Mines, Perth, Western Australia.

(15) *Publications*, Department of Mines, Hobart, Tasmania.

(16) *Publications*, Geological Survey, Canada, Ottawa, Ontario.

(17) *Publications*, Bureau of Mines, Toronto, Ontario.

(18) *Publications*, Geological Survey of India, Calcutta.

(19) *Publications*, Geological Survey, U.S.A., Washington.

(20) *Publications*, Geological Survey, Alabama, Montgomery, Ala.

(21) *Publications*, California State Mining Bureau, Sacramento, Cal.

(22) *Reports* Aust. Assoc. Adv. Science, Sydney, New South Wales.

(23) *Transactions and Proceedings*, New Zealand Inst., Wellington, New Zealand.

(24) *Quarterly Journal*, Geological Society, London.

(25) *Transactions*, Inst. Mining and Metallurgy, London, E.C.

(26) *Transactions*, Inst. Min. Eng., London.

(27) *Journal*, Canadian Mining Inst., Ottawa, Ontario.

(28) *Journal*, Chem., Min., and Met. Soc. of S.A., Johannesburg, Transvaal.

(29) *Transactions*, Am. Inst. of Min. & Met. Eng., New York City.

(30) *Proceedings*, Colorado Scientific Soc., Denver, Col.

(31) *Journal*, Franklin Inst., Philadelphia, Pa.

(32) *Australian Mining and Engineering Review*, Melbourne, Vic., mth., 6d.

(33) *Transactions*, Am. Soc. C.E., New York City.

(34) *Bulletins*, Société des Ingénieurs Civils, Paris.

(35) *Mining Magazine*, 819 Salisbury House, London, E.C., mth., 1s.

(36) *Publications*, Iron and Steel Institute, London.

(37) *Proceedings*, Inst. of Mech. Eng., London.

(38) *Publications*, Field Columbian Museum, Chicago, U.S.A.

(39) *Journal*, Mining Society of Nova Scotia, Halifax, N.S.

(40) *Transactions*, Mining and Geological Institute of India, Calcutta.

(41) *Publications*, Department of Mines, Wellington, N.Z.

(42) *Journal*, Chamber of Mines of West Australia, Perth.

(43) *Journal of Industrial and Engineering Chemistry*, Easton, Pa.

LIST OF ARTICLES.

MECHANICAL.

The Use of Oil in Diesel Engines. L. H. Morrison. (6) July 26, 1919.
Solving a Stack-Raising Problem. M. Fishback. (6) July 19, 1919.
Improved Turbo-Blower Unit. W. L. Wotherspoon. (6) May 17, 1919.
Progress in Manufacture of Stoping Drills. (6) May 31, 1919.
Car Dumpers. J. A. Jackson. (6) June 7, 1919.
Making Sharp Drills Effective. H. E. Scott. (6) June 7, 1919.
Economics in a Mine Power Plant. J. A. Carruthers. (6) June 14, 1919.
Automatic Car-Dumping Device. L. H. Goodwin. (6) June 21, 1919.
Shafting and Belting. R. S. Lewis. (6) June 28, 1919.
Repair Work in Milling Plants. C. Labbe. (6) June 28, 1919.
Oiling Mine Cables in Place. (8) May 31, 1919.
The Efficient Compression of Air. C. A. Hirchberg. (8) May 31, 1919.
Electric Hoisting Equipment at the Butte and Superior Mine. O. E. Jager. (8) July 5, 1919.
Method of Handling Granulated Slag at Anaconda. O. E. Jager. (8) July 26, 1919.
Skip-Changing Device at the Steward Mine. O. E. Jager. (8) Aug. 9, 1919.

METALLURGICAL.

Experiments in Magnetizing Roasting. G. J. Young. (6) Aug. 2, 1919.
Silver Volatilization in Smelting. F. P. Dewey. (6) July 19, 1919.
New Uses for Zinc. G. S. Harney. (6) July 19, 1919.
South African Gravity Stamp Practice. (6) July 19, 1919.
Copper Smelting Slag from the Microscopic and Chemical Point of View. C. G. Maier and G. D. Van Arsdale. (6) May 10, 1919.
Froth Removal from Dorr Thickener. C. T. Rice. (6) May 10, 1919.
Flotation of Mixed Copper Ores. (6) May 10, 1919.
The Mauss Centrifugal Separators. E. M. Weston. (6) May 17, 1919.
Control of Ore-Dressing Operations. G. J. Young. (6) May 24, 1919.
"Skin-Flotation" of Graphic Ores. (6) June 14, 1919.
Lime as a Settling Agent. P. T. Bruhl. (6) June 21, 1919.
Experimental Flotation Flask. W. H. Coghill. (6) June 21, 1919.
The Roasting and Magnetic Separation of Wisconsin Zinc Ores. E. G. Deutman. (6) June 28, 1919.
Sorting and Washing Plant for Magnesite Ore. (6) June 28, 1919.
Notes on Screening Practice. J. Bland. (6) June 28, 1919.
The Arizona Hercules Copper Company's Plant. (6) June 28, 1919.
Selection of the Power Plant for the Mill. G. J. Young. (6) June 28, 1919.
Milling in the San Juan, Colorado. C. R. Wilfley. (6) June 28, 1919.
Design of Small Metallurgical Mills. H. A. Megraw. (6) June 28, 1919.
Driers as Applied to Ore-Drying. L. R. Christie. (6) June 28, 1919.
Economics of Concentration. R. S. Handy. (6) June 28, 1919.
Notes on Flotation. J. P. Ruth. (6) June 28, 1919.
Working Adjustment of the Wetherill Magnetic Separator. G. J. Young. (6) June 28, 1919.
The Design of a Small Zinc Mill. W. F. Boericke. (6) June 28, 1919.
Homestake Tungsten Mill. (6) June 28, 1919.
An Outline of Flotation Test Work. H. L. Hazen. (6) June 28, 1919.
Ammonia Leaching of Copper Ores. L. Eddy. (6) June 28, 1919.
Developments in Lake Superior Milling. C. H. Benedict. (6) July 5, 1919.
Refining Flake Graphite for Crucible Use. F. S. Moses. (6) July 12, 1919.
Leaching of Oxidized Copper Ores with Ferric Chloride. R. W. Perry. (8) May 17, 1919.
Treatment of Complex Ores in Idaho. (8) May 24, 1919.
Mechanical Charging of Silver-Lead Blast Furnaces. L. D. Anderson. (8) May 31, 1919.
Recovery of Copper from Flotation by Leaching. P. R. Middleton. (8) June 7, 1919.
Power Requirements of Rock-Crushing Plants. M. H. Reasoner. (8) June 14, 1919.
Exit the Blast Furnace. O. E. Jager. (8) June 21, 1919.
Continuous Overflow and its Effect on the Slag Loss of Reverberatory Furnaces. O. E. Jager. (8) June 28, 1919.

Ball and Tube-Mill Drives at the Rochester Combined Mill. K. Freitag. (8) July 5, 1919.
Considerations on the Treatment of Flotation Concentrate. O. E. Jager. (8) July 12, 1919.
The Chloride-Volatilization Process. B. Stevens. (8) July 12, 1919.
A Device for Excluding Excess Air from Roasting-Furnaces. (8) July 12, 1919.
Exit the Blast Furnace. W. G. Perkins. (8) July 19, 1919.
Prolonging the Life of the Roofs of Reverberatory Furnaces at Anaconda. O. E. Jager. (8) July 19, 1919.
Electrolytic Deposition of Copper in the Leaching of Roasted Ores and Concentrate. P. R. Middleton. (8) Aug. 2, 1919.
The Horwood Process as Applied to the Copper-Zinc Ore of the Afterthought Mine. A. H. Heller. (8) Aug. 2, 1919.
The Chloride Volatilization Process. S. Croasdale. (8) Aug. 9, 1919.
A Step-Bearing for the Wedge Roasting Furnace. (8) Aug. 9, 1919.
A Safety Device for Exhausting Mercury Fumes During Steaming of Amalgam Plates. J. F. Walker. (28) May, 1919.
The Solubility of Gold in Cyanide Solutions. H. A. White. (28) July, 1919.
The Jenkins Electrolytic Cell. H. C. Jenkins. (35) June, 1919.

MINING.

Deep-Level Development in Aspen. F. W. Foote. (6) Aug. 2, 1919.
Sinking and Concentrating Mine Shaft 936 Feet Deep. R. L. Russell. (6) July 12, 1919.
A Peculiar Experience in Shaft-Sinking. A. Jarman. (8) June 21, 1919.
The Application of the Theory of Probability in the Determination of Ore Reserves. G. A. Watermeyer. Discussion. (28) June, 1919.
Modern Rock-Drill Practice. D. Pearman. (35) July, 1919.

MISCELLANEOUS.

Notes on Mill Fire Protection. D. Lay. (6) Aug. 2, 1919.
Labour and Gold Mining in South Africa. (6) May 24, 1919.
Mine-Dust Sampling. (6) May 31, 1919.
Federal Aid for Prospectors. E. J. Risdet. (6) June 7, 1919.
The Position of Gold. H. N. Lawrie. (6) Jue 7, 1919.
Engineering Standards Association. (6) June 21, 1919.
Specific Gravity Table. (6) June 28, 1919.
Wer's Influence on the Zinc Industry. P. Yeatman. (6) July 5, 1919.
Electric Blasting Equipment. L. D. Rowell. (6) July 12, 1919.
Blast Furnace Explosions. B. B. Hood. (6) July 12, 1919.
The Status of Gold. P. A. Robbins. (8) May 17, 1919.
Fire Prevention in the Butte and Superior. (8) May 31, 1919.
Use of Army Gas-Masks in Atmospheres Containing Sulphur Dioxide. A. C. Fieldner and S. H. Katz. (8) June 7, 1919.
The Status of Gold. J. C. M'Pherson. (8) June 14, 1919.
The Status of Gold. W. de L. Benedict. (8) June 21, 1919.
Industrial Co-operation. W. R. Ingalls. (8) June 28, 1919.
The Status of Gold. P. A. Robbins. (8) Aug. 2, 1919.
Notes on the Closer Working and Joint Housing of Technical and Scientific Societies on the Rand. P. Cazalet. (28) May, 1919.
Notes on Defective Air in Disused Raises and Backstopes. C. J. Gray. (28) May, 1919.
A " Safety First " Method for the Estimation of CO_2 in Mine Air. R. H. S. Wilkes. (28) May, 1919.

PROCEEDINGS

OF THE

AUSTRALASIAN

Institute of Mining & Metallurgy.

NEW SERIES.

No. 36.

21743
18.10.27

EDITED BY THE SECRETARY.

This Institute is not responsible, as a body, for the facts and opinions advanced in any of its publications.

31st DECEMBER, 1919.

PUBLISHED QUARTERLY BY THE AUSTRALASIAN INSTITUTE OF MINING & METALLURGY, MELBOURNE.

Australasian Institute of Mining and Metallurgy.

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Broken Hill	J. M. BRIDGE, c/o Zinc Corporation Ltd., Broken Hill, N.S.W.
Mount Morgan	B. G. PATTERSON, Mount Morgan, Q.

The Executive Committee consists of all Members of the Council residing, or for the time being, in Melbourne.

Head Office:

48 QUEEN STREET, MELBOURNE, VICTORIA.

Institute Matters.

CONTENTS.

	Page
MINUTES OF MEETINGS—	
Of the Institute	lxxvii
Of the Executive Committee	lxxx
NOTICES	lxxxiv
PUBLICATIONS—Added to Library	lxxxix
RECENT ARTICLES—On Mining Matters	xci

MINUTES OF MEETINGS.

OF THE INSTITUTE.

(SPECIAL GENERAL MEETING.)

MELBOURNE, 27TH AND 28TH OCTOBER, 1919.

IN THE ROOMS OF THE AUSTRALIAN METAL EXCHANGE, 56 QUEEN STREET.

Professor R. W. Chapman (Vice-President) occupied the chair until 11 a.m. on 28th October, and Mr. H. H. Schlapp for the remainder of the meeting.

The Secretary read the notice convening the meeting.

Copies of the draft Memorandum and Articles of Association issued to members on 6th October were submitted as a basis for discussion on the proposed re-organisation of the Institute.

Written communications on the subject were submitted from the various branches throughout Australasia, also letters from individual members.

It was resolved that it is desirable that the Institute incorporate in Victoria and register in each of the other Australian States and New Zealand.

It was further resolved that when the draft constitution was completed a legal authority be consulted.

The various clauses in the draft Memorandum and Articles of Association were then taken in order and discussed. As a result several amendments and additions were agreed upon and it was resolved that the constitution as amended be returned to the Council.

(FIRST ORDINARY MEETING, 1919.)

MELBOURNE, 29TH OCTOBER.

IN THE ROOMS OF THE AUSTRALIAN METAL EXCHANGE, 56 QUEEN STREET.

Professor E. W. Skeats in the chair.

The following resolutions were carried, viz. :—

(1) *Mine Managers' Certificates.*—That this Meeting request the Council to appoint a Committee to prepare a statement on the subject of certification of mine managers (*i.e.*, uniformity of examinations, reciprocity between States, etc.) such statement to be forwarded to the branches for report ; suggestions from the branches to be correlated by the Council ; the statement as amended to be forwarded again to the various branches ; the document when complete to be forwarded to the various Mines Departments as a recommendation from the Institute.

(2) *Degrees, etc.*—That it be a recommendation to the Council that, in future, degrees be given in the Register and published list of members, also after names of authors of papers unless otherwise requested by the author.

(3) *Advance copy of Summary of Paper to Press.*—That the Council consider the advisability of allowing a

paper or a summary of a paper that is to be presented to the Institute to appear in technical journals before appearing in the publication of the Institute Proceedings.

(4) *Publicity of Papers.*—That the Council consider the question of the publicity of papers of the Institute with the view of increasing the publicity of Australian mining and metallurgical practice. That the opinion of branches and interested members be invited upon the above question.

(5) *Service at the Front as a Qualification.*—That in future, in considering the claims of candidates for admission to the Institute or transfer to higher grade, every consideration be given to experience gained whilst serving with the Allied forces.

A paper by Mr. F. Danvers Power entitled "What is the Matter with Australian Mining?" was read by the chairman in the absence of the author and discussed.

The following papers were also presented and taken as read :—

"Underground Sampling," by Walter G. A. Smith.

"Notes on the Work of an Australian Tunnelling Company in France," by O. H. Woodward.

"Notes on the S. and M. Mine and on Treatment of Bismuth, Tin and Wolfram Ore," by Wm. E. Hitchcock and J. R. Pound.

In the evening the Institute Dinner was held at the Cafe Australia.

Mr. C. F. Courtney presided.

The following toasts were honored :—"Our Fallen Members," "The King" and "The Mining Industry," proposed by the Chairman ; "Returned Soldiers," proposed by Professor E. W. Skeats and acknowledged by Capt. A. G. Campbell, D.S.O., and Mr. J. R. Peberdy ; "Guests," proposed by Mr. Wm. Poole and responded to by Colonel W. L. Raws (Chairman of the Metal Exchange) and Mr. W. J. Newbigin (Senior Vice-President of the Institution of Engineers of Australia).

Of the Executive Committee.

(Summary)

November 3rd, 1919—1 p.m.

The Secretary's report was presented, and accounts to the amount of £90 were passed for payment.

A report from the Broken Hill branch in regard to the local library was submitted and it was resolved that the branch be requested to submit definite proposals in regard to its library.

Application for admission to the Institute were submitted and dealt with as follows :—As Members—Messrs. C. J. Emery, H. E. Clayton, T. G. Hanton, P. W. Moncrieff, and O. H. Woodward (transfer from Associate Member), approved ; Joseph Miller and J. H. Frank, deferred. As Associate Members—Messrs. R. B. Oliver and A. E. Fry, approved ; M. A. Williamson, H. J. Robertson and G. I. Adcock, deferred.

It was reported that the Broken Hill Mine Managers' Association had donated £100 to the branch for four prizes of £25 each for papers by members of the branch.

The following papers were recommended by the Publication Committee for issue in the proceedings :—

(1) "Underground Sampling," by Walter G. A. Smith.

(2) "Notes on the Work of an Australian Tunnelling Company in France," by O. H. Woodward.

(3) "What is the Matter with Australian Mining," by F. Danvers Power.

The appointment of a Sydney committee consisting of the following members was approved—Messrs. G. H. Blakemore, F. Danvers Power, Wm. Poole, F. A. Eastaugh, A. E. Savage, J. D. Audley Smith and A. A. Atkinson.

The following were appointed to represent the Institute on the Mining and Metallurgical Bursaries Committees—Brisbane University, Mr. A. A. Boyd ; Hobart University, Mr. H. W. Gepp ; Sydney University, Sydney committee to recommend.

The resignation of Mr. W. B. Blyth, who had severed his connection with mining, was accepted.

Suggestions in regard to the Draft Constitution made at the Special General Meeting on 27th and 28th October were reported and a revised draft was directed to be issued.

Recommendations from the First Ordinary Meeting, 1919, were postponed for consideration at the next meeting.

DECEMBER 1ST, 1919—1 P.M.

The Secretary's report was presented and accounts to the amount of £88 passed for payment.

Applications as follow for admission to the Institute were submitted and approved :—As Members—Messrs. David Avery, James R. Pound, Owen Beresford Williams ; as Associate Members—Messrs. Herbert James Robertson, Wilton Arthur Williamson and Garnet Ingamells Adcock.

Mr. William Poole was appointed to represent the Institute on the Mining and Metallurgical Bursaries Committee, Sydney University.

At the invitation of the Secretary, Department of Defence, a committee was appointed to consider, and, if possible, make arrangements for the publication of a book dealing with the offensive and defensive work underground during the Great War, by Australian Mining and Tunnelling Companies. The letter from the Defence Department stated that the Government would provide clerical assistance, the necessary maps and diagrams and access to all necessary records.

Recommendations from the First Ordinary Meeting, 1919, were considered and dealt with as follow :—

(1) *Mine Managers' Certificates.*—A committee was appointed to prepare a statement and to submit same to branches, and when finalized, to submit the recommendations to the various Mines Departments.

(2) *Degrees, etc.*—Suggestions that degrees, etc., be published in members' list and also after names of authors of papers was approved.—Publication Committee to supervise.

(3) *Advance Copy of Summary of Papers to be given to Press.*—Consideration of this question was postponed.

(4) *Publicity of Papers.*—This question to be again considered with No. 3.

(5) It was agreed that when nominations of candidates were under review, every consideration be given to experience gained whilst serving with the Allied forces.

(6) It was decided, as recommended, that an endeavour be made to ensure that the mining industry is represented on Standardisation Committees and on Advisory Councils of each State under the purview of the Institute of Science and Industry.

Other routine business was transacted.

DECEMBER 15TH, 1919—1 P.M.

The Secretary's report was presented and accounts to the amount of £43 passed for payment.

The following were elected to the Institute:—Members—Messrs. Cyril J. Emery, Thos. G. Hanton and Percy W. Monerieff. Transfer from Associate Member to Member—Messrs. William H. Bowater, Horace E. Clayton, Louis N. Stutterd and Oliver H. Woodward. Associate Members—Arthur E. Fry, Robert B. Oliver and Oswald M. Williams.

Nominations of Mr. William J. McBride as Member and of Mr. Norman R. Junner as Associate Member were approved.

Resolved that the technical press be permitted to peruse in the Institute Rooms MSS. of papers presented to the Institute and approved for publication in the Proceedings, and to publish a summary thereof, subject to the consent of the writer.

A printed circular, issued by a broker, containing certain statements on the values of ore reserves was submitted and the opinion expressed that the issue of such statements should be suppressed, and that the Stock Exchange should take steps to discourage such practice. Resolved that the matter be brought under the notice of the Australian Mines and Metals Association.

A suggestion that an invitation should be sent to the American Institute of Mining and Metallurgical Engineers to visit Australia was viewed with favor by the Executive Committee, but more definite information was desired in regard to ways and means.

A proposal that University students should be advised not to take part in strike-breaking, because of such action on their part seriously prejudicing their chances of employment later on, was discussed. It was shown that strike-breaking by students was not countenanced by University authorities; but harm had been done to students on certain occasions by Press reports. No action was taken.

NOTICES.

The rooms of the Institute are open from 9 A.M. to 5 P.M. daily, except Sundays and Public Holidays.

MEMBERSHIP.

Since the last issue of Proceedings the following have been admitted to the Institute :—

Members.

Names and Addresses.

BOWATER, WILLIAM HENRY, Thermo-Electric Ore Reduction Corporation, Wolfram, Q.

CLAYTON, HORACE EDWARD, Burma Mines Ltd., Burma.

EMERY, CYRIL JOHN, British Broken Hill Pty. Co., Broken Hill, N.S.W.

HANTON, THOMAS GLADSTONE, Zinc Corporation Ltd., Broken Hill, N.S.W.

MONCRIEFF, PERCY WOODS, Zinc Corporation Ltd., Broken Hill, N.S.W.

Transfer from Associate Member to Member.

STUTTERD, LOUIS NORMAN, Marranboy, Northern Territory.

WOODWARD, OLIVER HOLMES, Mount Morgan Co., Mount Morgan, Q.

Associate Members.

FRY, ARTHUR ERNEST, Zinc Corporation Ltd., Broken Hill, N.S.W.

OLIVER, ROBERT BRUCE, Tramway Terrace, Beryl Street, Broken Hill, N.S.W.

WILLIAMS, OSWALD MAURICE, Thermo-Electric Ore Reduction Corporation, Wolfram, Q.

Student.

WHITE, JAMES MURDOCK, Sulphide Corporation Ltd., Cockle Creek, N.S.W.

Applications for admission to the Institute have been received from the following :—As Members—David Avery, Collins House, Melbourne, Vic.; William John McBride, Broken Hill South Ltd.,

Broken Hill, N.S.W.; James Robert Pound, School of Mines, Ballarat, Vic.; Owen Beresford Williams, Block 10 Mine, Broken Hill, N.S.W. (transfer from Associate Member.) As Associate Members—Herbert James Robertson, Junction North Mine, Broken Hill, N.S.W.; Milton Arthur Williamson, Junction North Mine, Broken Hill, N.S.W. and Garnet Ingamells Adcock, Rutherglen, Vic. These names are now submitted to members for confidential report.

MOVEMENTS OF MEMBERS.

J. M. Bridge, Hon. Secretary Broken Hill Branch, spent his holidays in November and December in Tasmania. During Mr. Bridge's absence Mr. V. A. Haigh acted as Secretary of the Broken Hill Branch.

H. Wheeler Brown returned from Active Service on 24th November to his position on the staff of the Broken Hill Proprietary Co., Broken Hill.

C. H. J. Clayton has been on a visit of inspection to the wolfram district, North Queensland.

G. D. Delprat, General Manager Broken Hill Proprietary Ltd., has returned to Australia after an extended tour abroad.

R. J. Donaldson is now on the staff of the Sulphide Corporation Ltd. at Cockle Creek, N.S.W.

E. B. Dow has been transferred from the Central Mine, Broken Hill, to the Smelting Works of the Sulphide Corporation Ltd. at Cockle Creek, N.S.W.

E. C. Dyason left Melbourne on 19th November for India. He will be absent for about six months.

E. H. Fraser (Capt.) who returned from Active Service in March is now on the staff of the Broken Hill Associated Smelters Ltd. at Port Pirie, S.A.

H. W. Gepp, General Manager of the Electrolytic Zinc Co. of Australia, who has been for some months in America, expects to return to Australia before the end of this year (1919).

E. Howard Greig, of the Burma Mines Ltd., is now in Victoria on furlough. Owing to shipping inconveniences his journey to Melbourne occupied three months.

A. S. Lilburne, late Manager of the Mary Mac G.M. Co., W.A., is now General Manager of the Raub Australian G.M. Co., Raub, Pahang, Fed. Malay States.

R. Bert Millett, who elisted in 1916, has returned to Australia and is at present at Koorboora, North Queensland.

J. R. Peberdy will leave shortly for Koorboora, North Queensland.

Cecil Rae has returned to Ipoh, Perak, after four years service with the Indian Army in Persia and elsewhere. He finished his term of service with the rank of Lieut.-Colonel.

J. Murdock White, who recently returned from Active Service in France, is now with the Sulphide Corporation Ltd. at Cockle Creek, N.S.W.

O. B. Williams, who served with the A.I.F. abroad from 1915 to 1919, is again on the staff of the Block 10 Mine at Broken Hill.

EXTENSION OF SCOPE.

The draft constitution with amendments suggested at the Special Meeting in October is now in the hands of the drafting Committee and will be issued to members shortly for further consideration and comment.

PUBLICATIONS.

Papers included in this issue are :—

What is the Matter with Australian Mining? By F. Danvers Power.
Underground Sampling. By Walter G. A. Smith.
Froth Flotation at Broken Hill (with Discussion). By C. C. Freeman.

Discussion is invited.

The following papers will appear in the next issue :—

Notes on the Work of an Australian Tunnelling Company in France. By O. H. Woodward.
Some Controlling Factors in Flotation. By. R. D. Nevett.

RECOMMENDATIONS FROM FIRST ORDINARY MEETING.

The following recommendations from the First Ordinary Meeting have been approved by the Council, with the exception of Nos. 3 and 4 which are under consideration :—

(1) *Mine Managers' Certificates.*—That the Council appoint a Committee to prepare a statement on the subject

of certification of mine managers (*i.e.* Uniformity of examinations, reciprocity of States, etc.) such statement to be forwarded to the Branches for report; suggestions from branches to be correlated by the Council; the statement as amended to be forwarded again to the various branches; the document when complete to be forwarded to the various Mines Departments as a recommendation from the Institute.

(2) *Degrees, etc.*—That in future degrees be given in the Register and published list of members, also after names of authors of papers unless otherwise requested by the author.

(3) *Advance Copy of Summary of Paper to Press.*—That the Council consider the advisability of allowing a paper, or a summary of a paper that is to be presented to the Institute, to appear in technical journals before appearing in the Institute's Proceedings.

(4) *Publicity of Papers.*—That the Council consider the question of the publicity of the papers of the Institute with the view of increasing the publicity of Australian mining and metallurgical practice. That the opinion of branches and interested members be invited upon the above question.

(5) *Service at the Front as a Qualification.*—That in future, in considering the claims of candidates for admission to the Institute or transfer to higher grade, every consideration be given to experience gained whilst serving with the Allied forces.

(6) *Standardisation Committees.*—That the Council consider the question of approaching the Institute of Science and Industry to ensure that the mining industry is represented on the Advisory Councils of each State and on Standardisation Committees. (The Advisory Councils referred to are those which are to be established under the Institute of Science and Industry Bill now before the Commonwealth Parliament.)

THE WORK OF THE AUSTRALIAN MINING ENGINEER IN FRANCE DURING THE WAR.

The Secretary, Department of Defence, Commonwealth of Australia, has invited the Institute to undertake the writing and publication of a book of 250-300 pages on the offensive and defensive work underground during the Great War. The Council has accepted the invitation and has appointed a Committee to take the matter in hand. The Committee will, in the first place, ascertain if a desire exists among members and mining companies for such an important record to be written. The Committe would undertake the distribution of the book and the collection of subscriptions to cover the cost. It would also appoint a writer at a salary. The Government would provide clerical assistance, the necessary maps and diagrams, access to all records and space to work upon them. This work would be of great historic value especially to members of the Institute. Members will therefore be requested later to indicate whether they desire to take copies of the work when finished.

ANNUAL MEETING, 1920.

As previously announced the ANNUAL MEETING of the Institute will be held at the rooms, 48 Queen Street, Melbourne, on Friday, 30th January, 1920, at 1 p.m.

The business of the meeting will include :—

(1) Presentation of Annual Report and Balance Sheet.

(2) Recording the list of nominations received to fill the vacancies caused by retiring officers.

Nominations received are as follow :—President, Professor R. W. Chapman ; Vice-President, Mr. Colin Fraser; Councillors, Messrs. Robert C. Sticht, A. A. Boyd, W. E. Wainwright, G. H. Blakemore, James Hebbard, James Horsburgh and H. W. Gepp.

LIST OF PUBLICATIONS ADDED TO THE LIBRARY

From 30th September, 1919 to 31st December, 1919.

Australian Mining and Engineering Review	monthly	Melbourne
Industrial Australian & Mining Standard	-	Melbourne
Engineering and Mining Journal	weekly	New York
Iron and Coal Trades Review	weekly	London
Mining and Engineering World	weekly	Chicago
Mining Magazine	monthly	London
Indian Engineering	weekly	Calcutta
Chemical News	weekly	London
South African Engineering	monthly	London
Journal of Industrial and Engineering Chemistry	monthly	Easton, Pa.
Society of Chemical Industry : Journal	bi-monthly	London
Chemical, Metallurgical and Mining Society of South Africa : Journal	monthly	Johannesburg
Franklin Institute : Journal	bi-monthly	Philadelphia
Institution of Mechanical Engineers : Journal	monthly	London
Chamber of Mines of Western Australia : Journal	quarterly	Kalgoorlie
The West Australian Mining, Building and Engineering Journal	weekly	Perth
Queensland Department of Mines : Government Mining Journal	monthly	Brisbane
Transvaal Chamber of Mines : Monthly Analysis of Gold Production	-	Johannesburg
Rhodesia Chamber of Mines : Report of Executive	monthly	Bulawayo
New South Wales Board of Trade : Second Interim Report on Miners' Phthisis and Pneumoconiosis in Certain Industries	-	Sydney
Department of Mines, South Australia : Annual Report of Director for 1918		
Bulletin No. 7—The Phosphate Deposits of South Australia		
Review of Mining Operations for half-year ending 30th June, 1919	-	Adelaide
The University of Adelaide : Calendar, 1919	-	Adelaide

Department of Mines, Tasmania :
Annual Report, 1918 - - - Hobart
New Zealand Institute :
Transactions, Vol. 41, 1919 - - - Wellington
Geological Society :
Quarterly Journal, No. 295 - - - London
Geologists' Association :
Proceedings, Vol. XXVIII., Parts 1-3 ; Vol. XXIX., Parts 1-3 - - - London
Institution of Mining and Metallurgy :
Bulletins, Nos. 179 and 180 - - - London
Iron and Steel Institute :
Journal XCIX., No. 1, 1919 - - London
Institution of Mining Engineers :
Transactions, Vol. LVII., Parts 1-3 and 5 - London
Royal Dublin Society :
Economic Proceedings, Vol. II., Nos. 12 and 13 -
Scientific Proceedings, Vol. XV., Nos. 15-34 - Dublin
Annales des Mines : Vol. VI., Pages 87-304 -
Vol. VII., Pages 122-444 - Paris
Société des Ingenieurs Civils de France :
Mémories—7th Series, Nos. 10-12, 1918
8th Series, Nos. 1-6, 1919 - Paris
Societa Geologica Italiano :
Bulletin, Vol. XXXVII., Parts 2 and 3 - Rome
Geological Survey of India :
Records, Vol. L., Part 2 - - - Calcutta
Department of Mines and Geology, Mysore :
Records, Vol. XVI., Part II.; Vol. XVII., Part I. Bangalore
Department of Mines, Canada :
Memoirs, 107-110 and 112
Bulletins, Nos. 28 and 29 - - - Ottawa
Bureau of Mines, Canada :
Annual Report, Vol. XXVIII., Part II. - Toronto
American Institute of Mining and Metallurgical Engineers :
Bulletins, Nos. 154 and 155 - - - New York
Instituto Geologico de Mexico :
Annales, Vol. IV., Nos. 6 and 7 - - Mexico
Department of Mines, Mexico :
Bulletin, Vol. V., No. 4 - - - Mexico

RECENT ARTICLES ON MINING MATTERS.

(30th September, 1919, to 31st December, 1919).

NOTE.—*This list is prepared for the purpose of placing before members the titles of the more important papers appearing in the usual publications concerned with mining engineering, metallurgy, &c., due regard being had to Australasian requirements.*

LIST OF PUBLICATIONS.

References are given by the number prefixed to each publication in the attached list. Wk., weekly; mth., monthly.

(1) *The Industrial Australian & Mining Standard*, Melbourne, Victoria, wk., 6d.

(2) *The Queensland Government Mining Journal*, Brisbane, mth., 6d.

(3) *Metallurgical and Chemical Engineering*, New York, mth., 25c.

(4) *The Mining Journal*, London, E.C., wk., 6d.

(5) *Mining and Engineering World*, Chicago, wk., 10c.

(6) *The Engineering and Mining Journal*, New York, wk., 15c.

(7) *The Colliery Engineer*, Scranton, Pa., U.S.A., mth., 20c.

(8) *Mining and Scientific Press*, San Francisco, Cal., wk., 10c.

(9) *Annales des Mines*, Paris, France, mth.

(10) *Publications*, Department of Mines, Melbourne, Victoria.

(11) *Publications*, Department of Mines, Sydney, New South Wales.

(12) *Publications*, Department of Mines, Adelaide, South Australia.

(13) *Publications*, Department of Mines, Brisbane, Queensland.

(14) *Publications*, Department of Mines, Perth, Western Australia.

(15) *Publications*, Department of Mines, Hobart, Tasmania.

(16) *Publications*, Geological Survey, Canada, Ottawa, Ontario.

(17) *Publications*, Bureau of Mines, Toronto, Ontario.

(18) *Publications*, Geological Survey of India, Calcutta.

(19) *Publications*, Geological Survey, U.S.A., Washington.

(20) *Publications*, Geological Survey, Alabama, Montgomery, Ala.

(21) *Publications*, California State Mining Bureau, Sacramento, Cal.

(22) *Reports* Aust. Assoc. Adv. Science, Sydney, New South Wales.

(23) *Transactions and Proceedings*, New Zealand Inst., Wellington, New Zealand.

(24) *Quarterly Journal*, Geological Society, London.

(25) *Transactions*, Inst. Mining and Metallurgy, London, E.C.

(26) *Transactions*, Inst. Min. Eng., London.

(27) *Journal*, Canadian Mining Inst., Ottawa, Ontario.

(28) *Journal*, Chem., Min., and Met. Soc. of S.A., Johannesburg, Transvaal.

(29) *Transactions*, Am. Inst. of Min. & Met. Eng., New York City.

(30) *Proceedings*, Colorado Scientific Soc., Denver, Col.

(31) *Journal*, Franklin Inst., Philadelphia, Pa.

(32) *Australian Mining and Engineering Review*, Melbourne, Vic., mth., 6d.

(33) *Transactions*, Am. Soc. C.E., New York City.

(34) *Bulletins*, Société des Ingénieurs Civils, Paris.

(35) *Mining Magazine*, 819 Salisbury House, London, E.C., mth., 1s.

(36) *Publications*, Iron and Steel Institute, London.

(37) *Proceedings*, Inst. of Mech. Eng., London.

(38) *Publications*, Field Columbian Museum, Chicago, U.S.A.

(39) *Journal*, Mining Society of Nova Scotia, Halifax, N.S.

(40) *Transactions*, Mining and Geological Institute of India, Calcutta.

(41) *Publications*, Department of Mines, Wellington, N.Z.

(42) *Journal*, Chamber of Mines of West Australia, Perth.

(43) *Journal of Industrial and Engineering Chemistry*, Easton, Pa.

LIST OF ARTICLES.

GEOLOGICAL.

Geology of Platinum Deposits, Part I. W. L. Uglow. (6) Serial commenced Aug. 30, 1919.
Geology of the Gogebic Range and its Relation to Recent Mining Developments. W. O. Hotchkiss. (6) Serial commenced Sept. 13, 1919.
Relation of Regional Deformations to the Distribution of Ore in the Pre-Cambrian. E. Y. Dougherty. (8) Aug. 16, 1919.
The Genesis of Quartz in Veins. G. J. Bancroft. (8) Sept. 27, 1919.
The Lead-Zinc Deposits at the Rhodesia Broken Hill Mine, Northern Rhodesia. S. J. Speak. (35) Oct., 1919.
Geology and Mining Methods at Pilares Mine. (29) Aug., 1919.

MECHANICAL.

The Economic Use of Coal for Steam-Raising and House-Heating. (16) Bull. No. 28.
Selection of the Power Plant for the Mill. G. J. Young. (6) June 28, 1919.
Shafting and Belting. R. S. Lewis. (6) June 28, 1919.
Repair Work in Milling Plants. C. Labbe. (6) June 28, 1919.
Working Adjustment of the Wetherill Magnetic Separator. G. J. Young. (6) June 28, 1919.
Pump Troubles. C. Labbe. (6) Aug. 9, 1919.
Water Jack-Hammer Contest at Tonopah. J. A. Carpenter. (6) Aug. 9, 1919.
Sealing Formations by Slime-Laden Fluid. S. S. Langley. (6) Aug. 16, 1919.
Pulverized Coal for Blast Furnaces. E. P. Mathewson and W. L. Wotherspoon. (6) Aug. 16, 1919.
An Automatic Iron Ore Unloader. (6) Aug. 23, 1919.
Pillar-Shaft Gyratories *vs.* Lever Type. R. L. Sites. (6) Aug. 23, 1919.
Improving Top-Landing Haulage Equipment. L. C. Moore. (6) Aug. 23, 1919.
Application of Air Drills to Mine Sampling. J. H. Eggers. (6) Aug. 30, 1919.
A New Flexible Coupling. (6) Sept. 6, 1919.
Trommel Screen Cleaner. C. Labbe. (6) Sept. 6, 1919.
Compressing Air for the Laboratory. A. E. Schiffeson. (6) Sept. 6, 1919.
The M'Lure Hydro-Electric Plant. (6) Sept. 13, 1919.
Development of Reciprocating Air Compressors. S. T. Nelson. (6) Sept. 27, 1919.
Diesel Engines in Power Plants. C. Legrand. (8) Sept. 13, 1919.
Another Skip-Changing Device. L. Eaton. (8) Sept. 27, 1919.

METALLURGICAL.

Potash Recovery at Cement Plants. (16) Bull. No. 29.
The Roasting and Magnetic Separation of Wisconsin Zinc Ores. E. G. Deutman. (6) June 28, 1919.
Notes on Screening Practice. J. Bland. (6) June 28, 1919.
The Arizona Hercules Copper Company's Plant. (6) June 28, 1919.
Details of Small Metallurgical Mills. H. A. Megraw. (6) June 28, 1919.
Economics of Concentration. R. S. Handy. (6) June 6, 1919.
Notes on Flotation. J. G. Ruth. (6) June 28, 1919.
An Outline of Flotation Test Work. H. L. Hazen. (6) June 28, 1919.
Ammonia Leaching of Copper Ores. L. Eddy. (6) June 28, 1919.
Schedule C, Now in Effect at Trail Smeltery. (6) Aug. 9, 1919.
An Improved Copper-Casting Machine. T. W. Cavers. (6) Aug. 9, 1919.
Losses in Furnace Slags. E. H. Robie. (6) Aug. 16, 1919.
Determination of Magnetite in Matte and Slag. F. G. Hawley. (6) Aug. 23, 1919.
Status of Flotation in Spain. (6) Aug. 23, 1919.
Improved Muffle Door. (6) Sept. 6, 1919.
A Bone-Ash Economy. C. R. Corey. (6) Sept. 9, 1919.
Determinating Silica in Uranium Ores. C. W. Davis. (6) Sept. 6, 1919.

Gravimetric Determination of Copper. (6) Sept. 6, 1919.
New Screen-Sizing Scale Proposed. E. H. Robie. (6) Sept. 13, 1919.
Notes on Troubles from Colloids in Flotation. (6) Sept. 20, 1919.
Estimating Screen Efficiency. R. T. Hancock. (6) Sept. 27, 1919.
Apron Feeder for Wet Material. (8) Aug. 16, 1919.
Treatment of Tailing and Ore in the Sweeney Mill. R. S. Handy. (8) Aug. 30, 1919.
Blast Furnace *vs.* Reverberatory in Copper Smelting. E. P. Matthewson. (8) Sept. 6, 1919.
The No. 1 Concentrator of the Mountains Copper Company. L. C. White. (8) Sept. 6, 1919.
Blast Furnace *vs.* Reverberatory. C. V. Corless. (8) Sept. 27, 1919.
Utilizing Furnace Slag. W. M. Barker. (8) Oct. 4, 1919.
Handling and Smelting of Flue-Dust. W. M. Barker. (8) Oct. 25, 1919.
The Vacuum Process. T. S. Saunders. (8) Nov. 1, 1919.
The Hornet Crushing Plant. L. C. White. (8) Nov. 1, 1919.
Use of Pulverized Coal, with Special Reference to its Application in Metallurgy. L. C. Harvey. (39) Vol. XCIX., No. 1.
Modern Steel Metallurgy. C. H. F. Bagley. (39) Vol. XCIX., No. 1.
The Acid Hearth and Slag. J. H. Whiteley and A. F. Hallimond. (39) Vol. XCIX., No. 1.
Deoxidation and the Influence of Lime on Equilibrium in the Acid Open-Hearth Furnace. B. Yaneske. (39) Vol. XCIX., No. 1.
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MINING.

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MISCELLANEOUS.

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Papers and Discussions.

CONTENTS.

PAPERS—

	Page
Tapping Water by Diamond Drill Holes (with 1 Plate and 1 Fig.). By Edmund B. Dow	1
Isometric Mine Plans (with 9 Figs.). By H. Edward Clayton	9
Ore-Treatment Plant and Treatment Operations at the Edna May Gold Mining Company N.L., Westonia, W.A. (with 1 Fig.). By M. T. Williams	19
Notes on Cornish Tin Mining. By the late W. F. McBryde Brown	27

TAPPING WATER BY DIAMOND DRILL HOLES.

By Edmund B. Dow.

On mineral lease 38 of the Sulphide Corporation Limited, Broken Hill, a shaft was sunk in the early days for prospecting purposes and at the present time it is accessible as far as the 1000-ft. level where a connexion exists with the main workings of the Corporation's Central Mine, mineral lease 9.

About the year 1895 a crosscut was driven east from this shaft at the 1330-ft. level cutting the Central ore-body in mineral lease 9 and the shaft is supposed to extend a further depth of 25 ft., but no records of any of this work are in existence, the whole of the evidence being based on hearsay and memory.

Fig. 1 shows the position of the Extended shaft in relation to the main workings.

The shaft filled with water to the 1000-ft. level where it overflowed through the crosscut to the main shaft and was pumped to the surface, but when the South drive on the 1300-ft. level was pushed to the southern boundary, it was deemed advisable, for safety, to tap the water at this level and so relieve the

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pressure. The water in the old crosscut was the chief anxiety on account of the proximity to the South drive on the 1300-ft.

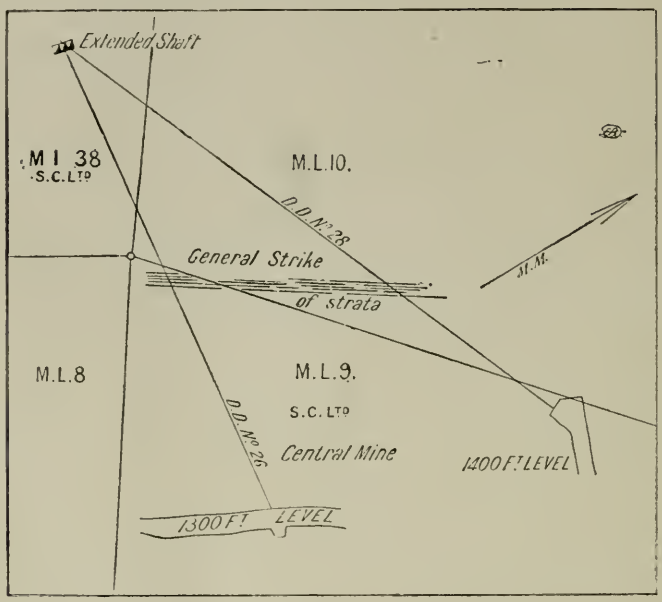


FIG. 1.
PLAN OF EXTENDED SHAFT AND BORE-HOLES.
Scale—100 ft. to 1 in.

level, being but 60-ft. below this, and about 40-ft. above the workings on the 1400-ft. level, which was then in course of being opened.

Several drill holes were put down in the assumed direction of the crosscut, but without success, and it was then decided to bore direct to the shaft and thus drain it of 300 ft. of water and so relieve the pressure to that extent. As it was desired to have the water under control, arrangements were made, as described below, for fitting a valve in the bore-hole so that at any time this could be closed and thus use the 300 ft. of shaft as a storage reservoir.

After drilling some distance the hole was reamed for a distance of 10 ft. from the collar and a pipe driven in, threaded

at the outer end to take the valve. The pipe was bound with marlin for about two feet at the inner end, a sheet of lead crimped over the end and then driven home tight against the shoulder left by the reamed hole. Drilling was then restarted and, after cutting through the lead flange on the end of the pipe, continued for a total distance of 261 ft., when the shaft was entered and the water flowed freely.

When the valve was fitted and closed, there was found to be a considerable leakage taking place around the outside of the pipe and also through cracks in the country-rock adjacent to the hole. This was due partly to the failure of the lead and hemp joint and partly to the fact that the short length of reaming had not carried the pipe beyond the ground that had been shattered by blasting. However, the work was satisfactory in that the shaft could be drained to this level and to a very large extent could be controlled when necessary.

Fig. 1 shows the position of this hole, which was No. 26.

When the main crosscut on the 1400-ft. level had passed through the lode the problem again confronted the management of how to drain the Extended shaft, and more especially the crosscut whose position was so obscure. Although the crosscut was 40 ft. above this level it was thought advisable to drain it before driving south along the lode, for fear that a crack or fissure might cause a rush that might be very inconvenient, if not dangerous.

It was therefore decided that a hole, No. 28, should be drilled from the end of the crosscut to intersect the shaft at some point below the level of the crosscut at the Extended shaft. The bottom of the shaft was supposed to be 25 ft. below the 1330-ft. crosscut and the hole was laid out to cut the shaft about 6 ft. below the crosscut level. Even then there was some doubt as to getting a clear outlet for the water as it was known that a considerable quantity of dirt had gone to the bottom during certain work on the 500-ft. level and other repairs to the shaft. This had occurred so many years previously that it would probably be cemented into a solid mass.

The elevation necessary for the hole was 5° and the calculated distance from the collar 310 ft. The direction of the hole was such that it made an angle of 37° with the strike of the country and, to avoid as far as possible any tendency of the drill bit to run off its true course, a new set of boring rods was obtained for the work. This insured that all joints in the rods would be tight, giving no tendency for play when connected up.

The drilling was in the hands of the Goldfields Diamond Drilling Company, a type H machine being used, with hydraulic feed and cutting a hole $1\frac{13}{16}$ in. diam. with a $1\frac{1}{8}$ in. core.

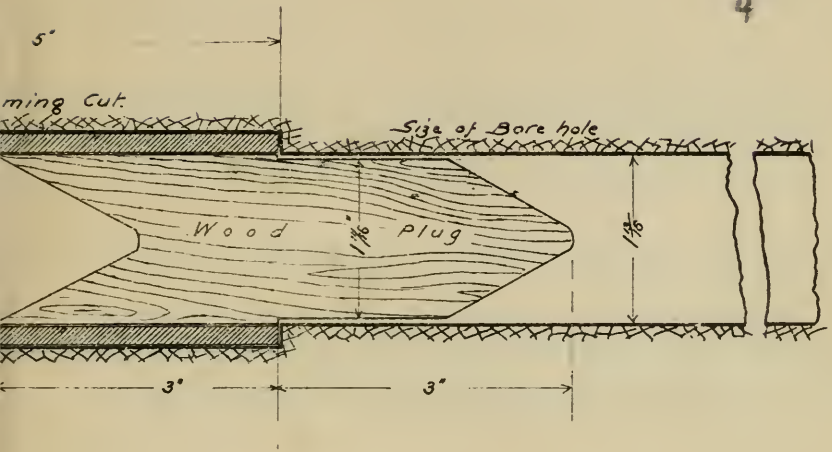
In view of the experience on the 1300-ft. level, more care was exercised in making a watertight joint at the collar of the hole, it being decided to put in a 30-ft. length of casing and then blow cement around the outside of it to insure against leakage. The hole was drilled for a distance of 97 ft. before arrangements were completed for reaming and this depth of hole insured against any vibration, which might occur in the first 30 ft. of casing, being transmitted to the drill bit and thus cause any deviation. These extra precautions were taken to offset as much as possible the liability to deviation due to the strike of the country.

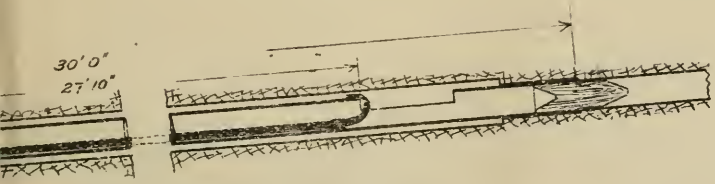
All the arrangements for the caulking of the hole were in the hands of Mr. N. J. Roberts, underground manager, and were carried out as now described.

The hole was first reamed to a diameter of $2\frac{1}{4}$ in. for a distance of 29 ft., to take the ordinary flush-jointed casing of $2\frac{1}{4}$ in. external and $1\frac{7}{8}$ in. internal diameter. A second cut was then reamed to a diameter of 3 in. for a distance of 28 ft. 7 in., leaving the hole the shape as shown in section (see Plate I). A length of casing (10 ft.) was prepared with a slot 6 in. long, cut to half the diameter of the casing and starting about 8 in. from the end. This was to allow the cement to flow between the casing and the ground.

In the end was driven a soft wooden plug, as shown. The plug was pointed at the forward end to give it a lead into the running bore hole and to insure the concentricity of the casing

4R

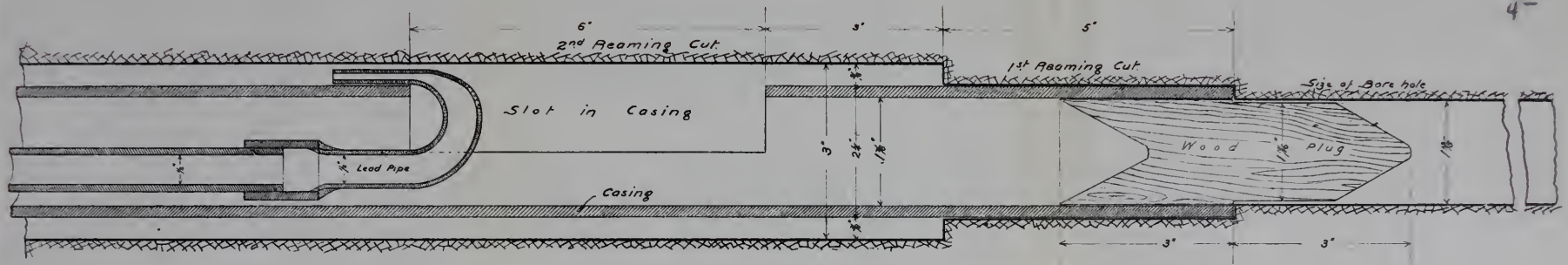


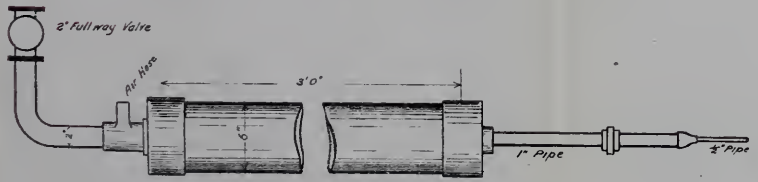


Inclination 5°

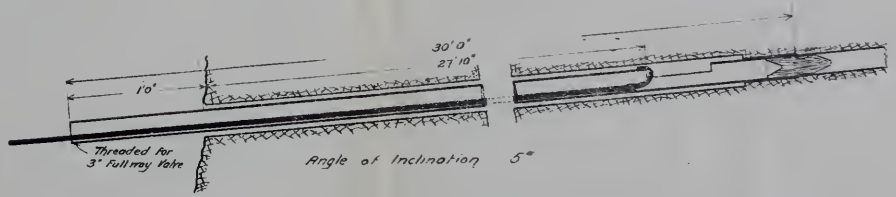
ARRANGEMENT.

4½





CEMENT GUN



GENERAL ARRANGEMENT

SHOWING METHOD OF CAULKING BOREHOLE.

and hole. The back end was coned out so that when drilling was restarted the bit would cut normally through the plug and enter the hole centrally. It was proposed to blow the cement into the hole by air-pressure through a $\frac{1}{2}$-in. pipe, led through the casing and turned through the slot into the annular space between casing and ground.

The end of this $\frac{1}{2}$-in. pipe was provided with a socket to which was soldered a short length of $\frac{1}{2}$-in. lead pipe. This was passed up through the casing and the lead pipe was bent outwards through the slot and carefully dressed to a flattened section that would pass the annular opening, which was only $\frac{3}{8}$ in. wide. The bent over portion was then securely bound in position with string and the remaining lengths of pipe connected up. The casing was in three lengths of 10 ft. each and the centre of the middle length was tapped with four holes. On two lengths being screwed together with the slot upward, a set screw with a head $\frac{3}{8}$ in. thick was screwed into the undermost of the four holes and the casing pushed home. This stud resting on the bottom of the hole prevented any sagging in the column and insured a straight line of casing. The remaining holes were plugged with waste. In this manner the three lengths of casing and the accompanying $\frac{1}{2}$-in. pipe were connected up and pushed into the reamed hole until the position was reached where the first reduction of diameter took place (See Plate I.). The casing was then driven home for a distance of 5 in. until the wooden plug entered the drill hole and the end of the casing butted against the shoulder where the first reaming cut had finished.

When all was secure a length of about 12 in. of casing was protruding from the hole and this had previously been threaded to take a 3-in. full-way valve when boring was completed.

The "gun" used for blowing the cement was a makeshift, assembled out of piping, as shown in Plate I. A 3-ft. length of 6-in. piping was picked up on the surface and found to hold sufficient cement to fill the annular opening and hence it was used in preference to any other more complicated apparatus. Before being sent underground it was tested to the full air-

pressure of 90 lb. The gun was placed in position and connected to the ½-in. line by suitable reducers, and a charge of water was first blown through to prove that all was clear. The cement was mixed in a tub using a 1 to 1 mixture of specially screened cement and sand. It was mixed fairly thin and rapidly bucketed in through a funnel, inserted in the 2-in. valve, till the gun was full. The valve was closed and air turned on, and, as soon as the cement was running freely from the collar, the annular space was caulked with waste and wooden wedges. To allow for leakages and a residuum in the gun, another charge of cement was blown in until it began to run from the inside of the casing. It was then assumed that the annular space was filled and overflowing back through the slot. The gun was then disconnected but the ½-in. pipes were still left in position until the cement had set. It so happened at this time that the mine had to stop production and it was two weeks later before the work was inspected. The stoppage was convenient in one regard—it gave plenty of time for the cement to set and assured those in charge of the work of safety in this respect. The ½-in. pipes were then pulled out, breaking at the soldered joint between the lead and iron.

When drilling restarted a calyx bit was used to cut through the lead pipe and wooden plug, and, when the diamond bit was put on, no difficulty was encountered in entering the original hole. A small amount of cement had set on the inside of the casing but gave no trouble and soon wore away with the rotation of the rods.

There were two reasons for having the slot cut in the top side of the casing and not on the lower side, and care was taken, in placing the casing in position, that the slot should remain on the top side. Firstly, as the hole was elevated slightly, this position of the slot insured filling the space for a greater length, and, secondly, it prevented the formation of a pocket which would provide a lodging place for any carbons which might become detached from the bit.

Thus far the work had been satisfactory but disappointment was in store, for when the shaft was reached it was found to be filled with rubbish and mullock to a greater height than was anticipated. The core consisted of pebbles quite foreign to the adjacent strata and these were seamed and stained with iron and thoroughly cemented together. In fact, the mass was so compressed and so well cemented that the flow of water obtained was not sufficient to drain the shaft and crosscut as intended. After drilling ceased a valve and pressure-gauge were connected to the casing, and, with this valve closed and also the valve on bore No. 26 on the 1300-ft. level, a pressure of 160 lb. was registered. This represents a head of 370 ft., showing that the full pressure from the 1000-ft. level was available at the gauge.

Various suggestions were put forward for increasing the flow of water. The compressed-air main was connected up with the casing till the full pressure of 90 lb. was registered, and then suddenly released. A handful of pebbles were released from the shaft, but repeated attempts did not increase the flow of water.

A suggestion to push up a charge of gelignite at the end of a column of pipes and fire this electrically was discussed, but it was thought that the material forming the container, as well as the pipes themselves, might effectively block the hole up altogether.

Although the object of the drill was not achieved the cementing of the casing was entirely successful and it is for this the paper is written. With a pressure of 160 lb. on the pressure-gauge there were no leaks whatever, either around the casing or through cracks in the country-rock, and, as this represents the highest pressure which would ever come on the joints, an efficient control for the water had been established.

ISOMETRIC MINE PLANS: Their Applications, Limitations, and Method of Construction.

By H. Edward Clayton.

In the construction of a set of ordinary mine plans, two axes or co-ordinates are used; also, two different projections are essential —viz., a plan (horizontal projection) and longitudinal section (vertical projection).

In isometric projection three axes are employed—one axis vertical and the remaining two inclined to it at angles of 120°, also, making an angle of 120° with one another, as shown in Fig. 1. The two inclined axes are used to plot the horizontal projection, while altitudes are plotted on the vertical axis.

As an illustration, consider the case of a simple object, such as a box. To show all the dimensions in the usual manner requires

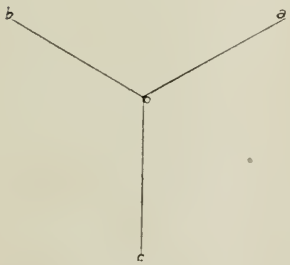


Fig. 1.

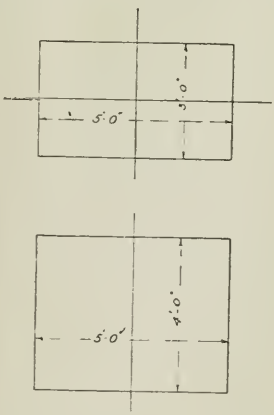


Fig. 2.

two drawings—a plan and elevation, as in Fig. 2. By viewing

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the box at a depression angle of 45° all the dimensions are disclosed, and the box may be thus projected on isometric co-ordinates as in Fig. 3. This principle has been applied to the construction of mine plans. Originally brought into use almost a century ago, it has fallen into disuse, but has of late years been revived on some mines. A few illustrations of its application are now given.

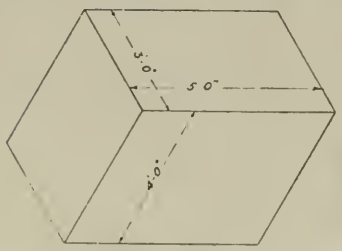

FIG. 3.

In the ordinary system of rectangular co-ordinates, in the case of mines working flat lodes, it is common practice to show stoping on the usual horizontal working-plan ; while with vertical lodes and those approaching the vertical the stoping is plotted on the longitudinal section. When, however, the ore-body consists of two or more parallel lodes, the stopes overlap and the system becomes somewhat confused, especially when viewed by one not accustomed to the mine.

In such cases the isometric projection can be used with advantage, for, although the stopes may overlap if the two branches of the level are close together, it is easily seen to which drive each set of stoping belongs, as the levels are shown in plan and elevation combined.

Again, an isometric plan being virtually a projection on a plane inclined at 45°, the nearer the dip of the lode approaches this figure so is the outline of the stoping more truly shown. This fact is the chief merit of an isometric in the case of a mine whose ore-body dips at about this angle, for, if the stopes be surveyed by means of offsets from a line between two points whose location can be determined on the isometric, the survey may be plotted direct in its true dimensions without further calculation.

With descriptive plans, such as those showing ventilation systems, etc., the isometric is also to be preferred to the longitudinal section, since every part of the mine appears on the one drawing.

On the other hand, the angles employed in surveying lying about the horizontal and vertical axes make it impossible to read bearings, or plot direct by means of bearings, unless considerable calculation is employed to combine the horizontal and vertical angles. Hence it is customary for all work to be plotted first on the ordinary working-plan and then transferred to the isometric.

Again, while it is possible to so construct these plans as to be able to scale off the correct northing and southing of a point, neither the easting nor the depth (except in the case of a vertical shaft) can be determined.

For ordinary mine work, the defects quoted above render the isometric plan somewhat cumbersome and unnecessary, but in the instances previously given the system can be applied with good results.

Methods of Construction.

In order that distances may be measured with the ordinary scale on the completed plan, it is necessary to first construct an isometric scale. The basis of construction lies in the fact that the isometric scale used in plotting bears the ratio of $\sqrt{3} : \sqrt{2}$ with regard to the ordinary scale.

The construction is shown in Fig. 4. Mark off a line, AB, 100 ft. long to the scale of the ordinary plan; on one end, A, erect a

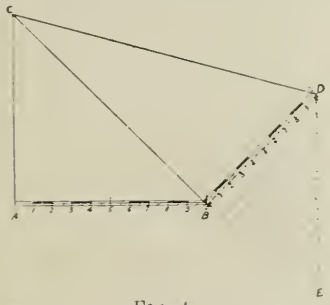

Fig. 4.

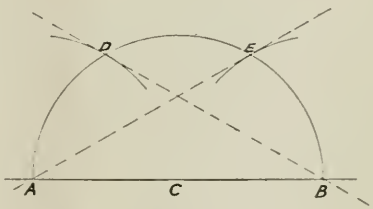

Fig. 5.

perpendicular, and by a line BC inclined at 45° to AB complete the 45° triangle.

At B draw BD perpendicular to BC, and complete the triangle by a line CD, making an angle of 30° with BC.

BD is then divided proportionally, and is the isometric scale of AB, for it will be seen that AB is $\frac{1}{\sqrt{2}}$ and BD is $\frac{1}{\sqrt{3}}$ of the common hypotenuse.

The easiest way to divide BD is to draw any line DE, mark it off with the ordinary scale, join BE and draw parallels to it to complete the scale.

Although the plan is based on the principle of three co-ordinates, only two sets are used in practice, for reasons which will be later explained. These two sets of co-ordinates are drawn at angles of 30° to the horizontal, and, in laying out the first principal ones on the plan, the following method can be used, as shown in Fig. 5.

Take any long base, AB; bisect at C; with centre, C, draw a semicircle. From centres A and B, with the same radius, strike

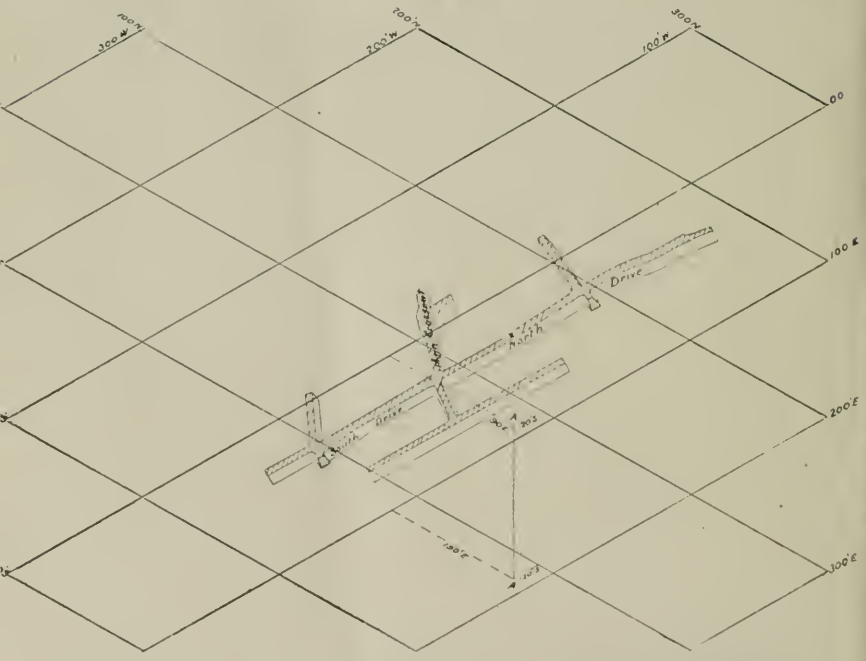

FIG. 6.

arcs intersecting the semicircle at D and E. Join AE, BD. The

remaining co-ordinates are drawn parallel to these lines at 100 ft. intervals, measured on the isometric scale, the plan appearing as in Fig. 6.

In plotting, consider any point on the surface, its co-ordinates being 20 ft. S., 90 ft. E.; the position is shown at A, Fig. 6. Now take another point 100 ft. vertically below it, having, of course, the same co-ordinates. The vertical is drawn in the figure to a depth of 100 ft., and the point marked. It is now found that the new isometric co-ordinates are 120 ft. S. and 190 ft. E.; but, as it is too confusing to plot in the above manner, the method adopted is to add the reduced level of each point to its co-ordinates. Thus, a point 350 ft. S., 100 ft. E., 220 ft. reduced level, becomes 570 ft. S., 320 ft. E., on the isometric co-ordinates.

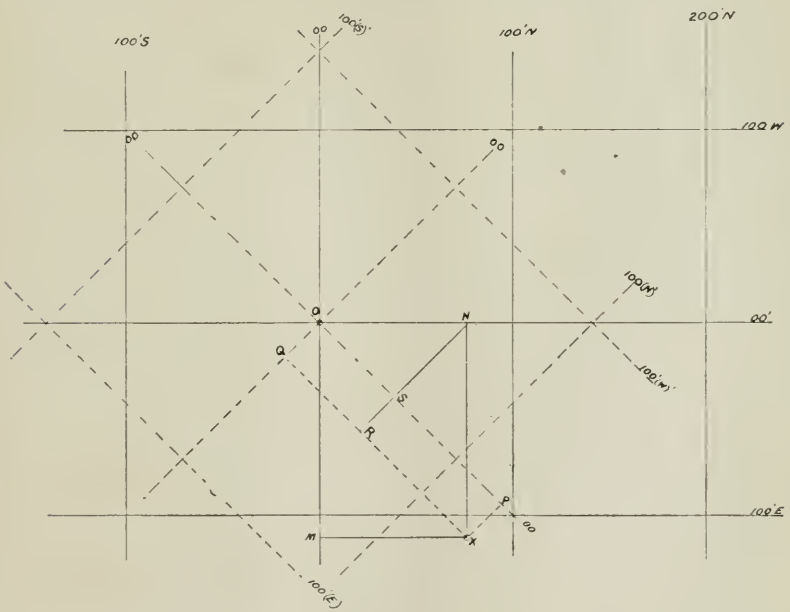

FIG. 7.

Then, should the general strike of the ore-body be parallel, or nearly so, to one of the co-ordinates, as is usually the case, on plotting the result will be as though the mine were viewed from

the north-east corner, and the plan will lie obliquely, as also shown in Fig. 6.

In order that the plan shall plot so that true distances north and south may be measured, it is necessary to rotate the original co-ordinates of the mine through an angle of 45°, and assign new isometric co-ordinates to each point.

There are two methods by which this can be done, the first method given being much quicker than the second, only perhaps not quite so accurate. They are as follows :—

(1) *Mechanically*, by drawing a set of rectangular co-ordinates on tracing linen, then by fastening with a pin to the plan at the point of origin, rotate through an angle of 45°. Each point to be plotted can then be seen through the tracing and the new co-ordinates assigned.

(2) *By calculation* ; referring to Fig. 7, the original co-ordinates are shown in heavy lines, while the new rotated sets are shown dotted.

Take any point, X ; the northing (N) is XM, the easting (E) XN. The isometric northing (N′) is XQ, and the isometric easting (E′) XP.

Draw NR perpendicular to XQ, intersecting OP at S.

Then $XQ = QR + RX$.

$$QR = OS = \frac{ON}{\sqrt{2}} = \frac{N}{\sqrt{2}}$$

$$RX = \frac{NX}{\sqrt{2}} = \frac{E}{\sqrt{2}}$$

Therefore $N' = \frac{N}{\sqrt{2}} + \frac{E}{\sqrt{2}}$

$XP = RS = NR - NS$.

$$NR = \frac{NX}{\sqrt{2}} = \frac{E}{\sqrt{2}}$$

$$NS = \frac{ON}{\sqrt{2}} = \frac{N}{\sqrt{2}}$$

Therefore $E' = \frac{E}{\sqrt{2}} - \frac{N}{\sqrt{2}}$

With the point X all distances measured are positive ; where distances south and west occur, they introduce negative values.

The new rotated co-ordinates of a point having been determined by either of these methods, it is then necessary to add to them the depth or reduced level of that point.

Working by the second method (calculation), the formula for any point becomes—

$$N' = \frac{N}{\sqrt{2}} + \frac{E}{\sqrt{2}} + D \qquad E' = \frac{E}{\sqrt{2}} - \frac{N}{\sqrt{2}} + D$$

N′ being isometric northing.

E′ being isometric easting.

N being original surveyed northing.

E being original surveyed easting.

D being reduced level.

For distances south and west, reverse the corresponding signs.

Now, in a set of co-ordinates shown in Fig. 6, the co-ordinates are marked with distances north and south, east and west, of the origin, thus entailing four sets of numbers. These can be reduced to two sets if N′ and E′ are kept positive. This is done by estimating the maximum southing and westing (negative values), which will be required.

Suppose, therefore, that the limits of the original plan are 500 ft. N., 1500 ft. S., and 2000 ft. W., the maximum negative values produced are :—

$$N' = -\frac{1500}{\sqrt{2}} - \frac{2000}{\sqrt{2}}$$
$$= -1065 - 1420$$
$$= -2485$$

$$E' = -\frac{2000}{\sqrt{2}} - \frac{500}{\sqrt{2}}$$
$$= -1420 - 355$$
$$= -1775$$

Thus, by giving the origin of the plan a position of 2500 ft. N. and 2000 ft. E. (round numbers are given for convenience), all negative values are cut out.

By the template this is done by marking the origin of the co-ordinates on the tracing linen with these values and fastening

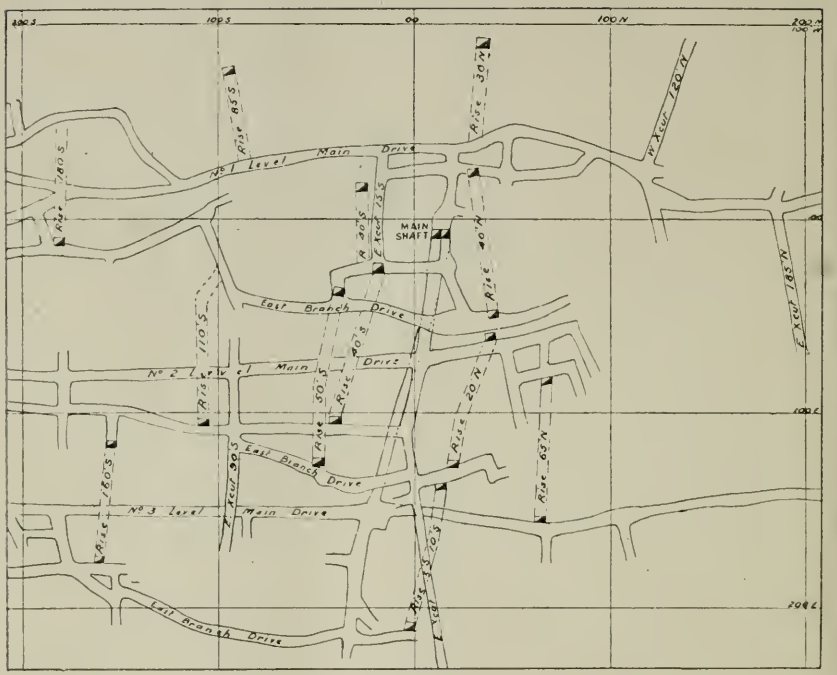

FIG. 8.
WORKING PLAN.

to the origin of the ordinary rectangular plan at this point.

In the formula method it is done mathematically, so that the formulæ finally become—

$$N' = \frac{N}{\sqrt{2}} + \frac{E}{\sqrt{2}} + D + 2500.$$

$$E' = \frac{E}{\sqrt{2}} - \frac{N}{\sqrt{2}} + D + 2000.$$

The complete scheme of operations may be summarized as follows :—

(1) Construct the isometric scale as in Fig. 4.

(2) Lay out a set of isometric co-ordinates, as shown in figs. 5 and 6.

(3) Determine maximum negative values required, and, if working by the template method, mark the origin with these values.

(4) By either template or formula calculate new isometric co-ordinates for each point to be plotted.

In fig. 8 a working plan is given, and its isometric projection shown in Fig. 8*a*. The formulæ used in plotting this plan are not

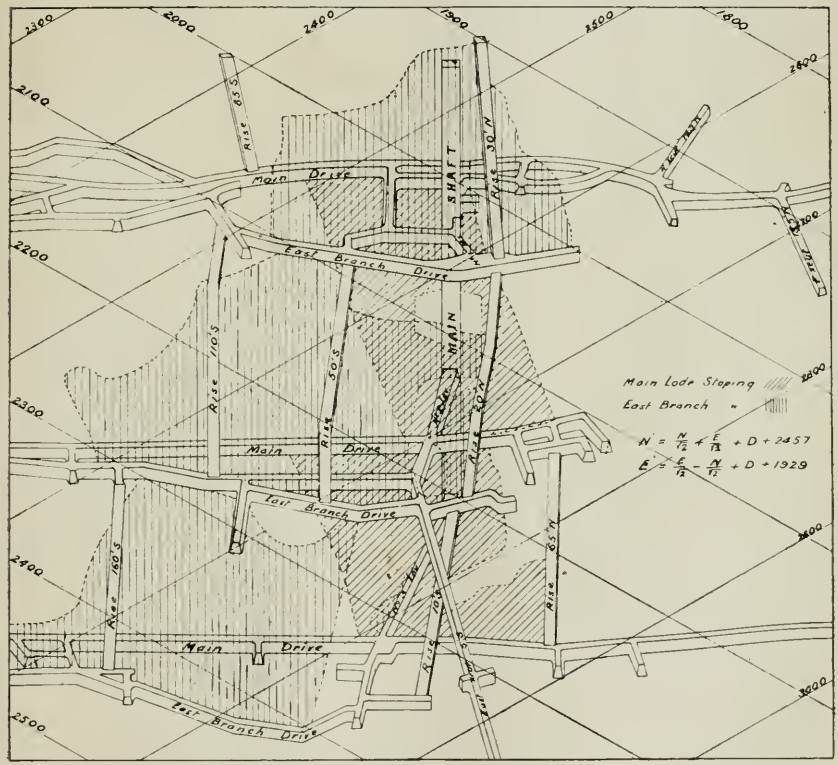

FIG. 8A.

WORKING PLAN—SHOWING ISOMETRIC PROJECTION.

the ones previously derived, since Fig. 8*a* is a copy of portion of an existing plan in which different constants were used. It will be seen that with a north and south drive the hanging-wall side and

back of the level are exposed, requiring three lines, while in an east and west crosscut two sides and the back are visible, requiring four lines. With a rise running due east or west, only the hanging-wall is seen, and, when inclined, one of the sides in addition.

The levels should be coloured with tints corresponding to the working-plan, the back of the levels being given a darker wash. Rises and winzes are coloured neutral tint, the sides (where visible) being shown darker.

Stoping on the various lodes is shown by a characteristic form of hatching for each lode.

ORE-TREATMENT PLANT AND TREATMENT OPERATIONS—EDNA MAY GOLD MINING COMPANY N.L., WESTONIA, W.A.

By M. T. Williams.

Nature of Ore.

The Edna May ore consists mainly of clean quartz of a moderately hard and tough nature. The gold content is "free" and fairly coarse, so that a large percentage is recovered by amalgamation. The ore is practically free from metallic minerals.

General Outline of Plant and Treatment.

The ore, received from underground in trucks, is broken by a jaw breaker, then stamp-milled, followed by partial fine-grinding in pans. Mercury is used both in the mill boxes and pans. The pulp, on leaving the pans, passes over amalgamating tables and is then elevated by tailings pump to cone classifiers and separated into a sand and slime product, each product receiving a separate cyanide treatment—sand by leaching in vats and slime by agitation and decantation in a "Trent" plant. Gold solutions from both sand and slime are precipitated together by zinc shavings in the usual type of precipitation boxes. Accumulated slime is trucked from the dam to a vortex mixer and from this point receives with the current slime the same treatment.

Ore Breaking and Transport.

The ore is trucked from the brace of the shaft along an overhead line to the breaker station. Here it is, by means of a "kick-up," dumped upon a grizzly, set with 2-in. spaces, the oversize being broken by a 15 x 9 Fraser and Chalmer jaw

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breaker to pass a 2-in. ring. The fines, together with the broken ore fall on to a sloping chute, then to a belt and bucket elevator, which delivers to the battery bin. This bin has a holding capacity of approximately 200 tons. Rock-breaking is done on two shifts only. Lime is added to the ore as it goes to the bin, and in such quantity as to keep the mill-water alkaline.

Milling, Fine-Grinding and Amalgamation.

The milling equipment comprises two five-head batteries, each stamp of which, when fully weighted with new shoes, etc., weighs 1250 lb. The battery frames are of the "E" type and the mortar boxes of the straight-back pattern for fast crushing. Sloping chutes deliver the ore from the battery bin to two "Challenge" ore-feeders. The stamps drop 108-110 times per minute from a height of 6½ in. and have an average duty of 10 to 11 tons per stamp per 24 hours. The order of the drop is 1, 3, 5, 2, 4. Wire-wove screens 8 x 8 x 18 are used. The life per screen varies from 5 to 7 days. Eagle and Globe also Sandycrofts mill shoes and dies are in use. Shoes last approximately 11 weeks and dies 10 weeks. Inside amalgamation in the mortar boxes is practised, but no inside silvered plates are used. In front of each 5-head battery is a 5-ft. diam. Watson and Denny grinding pan, which takes the whole pulp-flow from the battery screen. The screen discharge passes over a broad-lip launder before entering the pans. The pans are fitted with "Freeman" classifier discharge, and are run at 58 r.p.m. The shoes and dies have an average life of 23 days.

The pulp discharged from the pans passes over inclined amalgamating tables 12 ft. long by 5 ft. wide. The ends of the tables are fitted with mercury traps. From the tables the pulp is laundered to the tailings pump. The bottom of this launder is covered with coarse screening, which acts as a further trap for any escaped mercury or amalgam. The screens, lip launders, pans and amalgamating tables are all covered and locked. Gold recovered by amalgamation amounts approximately to 85 % and upwards of the total gold contents of the ore.

Classification.

The pulp from the amalgamating tables runs to the well of a belt-driven duplex plunger pump, 8-in. diam. by 30-in. stroke. The pump well is divided into two compartments, one for each pump suction, the one being used for the mill pulp and the other for the return-water overflow from the sand-collecting vats. The mill tailing is delivered to two "Caldecott" sand cones, run in series. The cones are respectively 6 ft. diam, by 7 ft. 6 in. depth, and 4 ft. 6 in. diam. by 6 ft. 6 in. depth. The overflow from the second cone runs to a mechanical slime-thickener, 8 ft. deep by 25 ft. diam., which overflows clear water back to the mill-water tank, and also from the overflow launder supplies water to run the sand from cone-underflows to the sand-collecting vats. There are six sand-collecting vats erected immediately above the treatment vats. In these collectors, opposite the inflow, is an overflow gate fitted with screening, against which a roller blind of canvas is so arranged that, as the sand rises in the vat the blind is gradually unrolled to raise the level of the overflow. The overflowing water runs to the second leg of the tailings pump which delivers back to the mechanical thickener. A sand trap is placed in the circuit before the thickener to eliminate any sand which may have escaped from the sand vats. The sand trap underflows to the mill pulp compartment of the pump well. Make-up mill water can either be run direct to the mill boxes or into the pump well. The underflow from the mechanical thickener is laundered to the slime-treatment section of the plant.

Sand Treatment.

This portion of the plant consists of six collecting and six treatment vats, built of corrugated galvanized iron, also two solution sumps, 20 ft. diam. by 4 ft. deep and two overhead weak-solution storage tanks each 16 ft. diam. by 8 ft. depth. A 3-in. centrifugal pump handles the solution from the sumps to the storage tanks or to each separate vat as required. The collecting vats are 8 ft. deep and have a diameter of 22 ft. The treatment

vats are 6 ft. deep with a diameter of 25 ft. In each vat, both collecting and treatment, the filter bottoms take up about 6 in. in depth. After draining for at least 48 hours the collected sand-charge of 100 tons in the top vats is transferred by shovelling through three discharge doors to the bottom treatment vats. The crushing is done in alkaline water, no lime being used in the vats. When the bottom vats have been filled and the sand-charge spread and levelled, 30 tons of cyanide solution of a strength of .12% KCN is pumped on and allowed contact for 12 to 16 hours before being allowed to drain. After draining the following 24 or 48 hours the sand-charge is used for clarifying the gold solution from the slime plant, then for the following 48 or 72 hours it receives three separate washes of 30 tons each of weak barren solution, .03% KCN, and when the vat is finally drained off it is ready for discharging.

The time required for complete treatment averages about six days per charge. The cyanide consumption averages about .40 lb. sodium cyanide per ton of sand, and the gold recovered amounts approximately to 80 % of the gold contents of the sand product.

Slime Treatment.

The slime treatment plant is of the "Trent" decantation type and comprises three separate "Trent" units, together with the necessary tanks for gold and weak barren solution storage, vortex mixer and centrifugal pump for handling accumulated slime and two 2-in. centrifugal pumps each for handling gold and wash-solution respectively. Each "Trent" unit is a steel vat 30 ft. in diameter and 18 ft. deep. To each vat is attached a 6-in. centrifugal pump with suction and delivery pipes so arranged that the slime pulp can be circulated over the whole depth of the vat, or portion of same, or only over a shallow zone from the bottom to two feet in height.

The pump suctions are at three different levels, namely at 2, 5 and 14 ft. from the bottom. The pump delivery-pipe passes through the centre of the vat bottom into a set of four movable

arms set at right angles. The arms are fitted with nozzles set at angles of approximately 45° from the horizontal downwards, and are so spaced that the whole area of the vat bottom is equally served by the moving arms, which are attached to a vertical shaft suspended on ball bearing on timber above the top of each vat. The motion of the arms is caused by the pulp-flow through the nozzles. This movement does not constitute any agitation, but is the means of evenly distributing the slime pulp over the vat bottom. The agitation proper is caused by circulating the slime pulp from the top suction through the vat bottom into the movable arms at a greater velocity than the settling rate of the slime. In addition to the proper suction pipes, there are two smaller auxiliary pipes connected to the pumps, through which, simultaneously to circulating slime pulp, barren solution and wash water can be respectively drawn.

Each unit performs all the operations required in the treatment of slime between the grinding and precipitation stages, and is a complete apparatus for collecting and agitating the slime pulp and finally for, by decantation, separating the gold solution from the barren pulp. These various functions are all performed and controlled by the proper use of the several pump suctions. Thus, in agitating, the pump is operating from the top suction only and the entire slime pulp will then be an even mixture constantly circulating in the vat from the bottom upwards. Air is at this stage introduced into the pulp. Atmospheric air is drawn in through the pump suction-pipe, which is atomized in the pump and thorougly distributed throughout the slime pulp. Compressed air is also blown in through a small pipe from the top to assist the agitation. Care has to be taken in not using more air than necessary for the dissolution of the gold, on account of the difficulty in again eliminating the minute air particles, which afterwards, whilst contained in the slime pulp, seriously retard the settling rate. When the gold has been efficiently dissolved, requiring, with the product being treated at present, a circulation of the pulp of from 4 to 8 hours, replacing or separation of the gold solution can be commenced. This

operation is done by changing from the top to the bottom suction of the pump. The circulation of the slime pulp is then confined to the lower portion of the vat only. In doing this a thickening effect on the circulating pulp is taking place, and the zone above the bottom suction becomes a quiet settling space. Replacing is effected by drawing through the auxiliary pipes first barren solution and later water, at a rate equal to or slightly less than the settling rate of the slime. Sufficient barren solution and water is taken in to replace the dissolved gold and also cyanide contents of the slime pulp. The clear solution on top is decanted and pumped to an elevated storage-tank, whence it can be run over any of the sand-treatment vats for clarifying before entering the precipitation boxes. The ratio of solution to dry slime is, for dissolving, 2 of solution to 1 of slime, and for efficiently recovering the whole, or practically so, of the dissolved gold-contents, 4 of barren and water wash is used, or in other words double the quantity of the original gold solution. The average charge being treated per unit amounts to about 150 tons of dry slime, and the time required for complete treatment is approximately 6 days. The time required varies according to the settling rate. With good settling slime the capacity of the plant can be materially increased. At present about one-third current slime (good settling) and two-thirds accumulated slime (poor settling) are being treated. With this mixture the monthly capacity is 1500 to 1600 tons.

The accumulated slime is trucked from the dam to a vortex mixer, where it is pulped with weak cyanide solution. Lime is added at the mixer in sufficient quantity to satisfy the acidity of the slime.

The mixer discharges over a double screen to the well of a 3-in. centrifugal pump, which delivers the pulp to the overhead launders where it mixes with the current slime pump.

The consumption of cyanide averages 0.80 lb. for current slime and 1.30 lb. sodium cyanide for accumulated slime per ton. The gold recovered amounts to 94 % of the total gold contents of the slime.

Disposal of Residues.

The disposal of residues is effected by a pumping scheme. A set of launders serves each sand vat and delivers to the suction of a 6-in. belt-driven centrifugal pump. A 4-in. pipe service supplies mine water to the head of each launder. The sand is shovelled through the two discharge doors in each vat into the launders, and from here the water carries it to the pump. The pump delivers to a vertical height of 35 ft. and then through 700 ft. of pipeline to the residue dump. In 4 hours 100 tons of sand can be pumped out. The sand-shovelling is done by contract. The slime-plant residues are also laundered to this pump and discharged to the same dump. In 4 hours 150 tons of slime can be pumped out.

Precipitation, Clean-up and Smelting.

In the mills the plates are cleaned and scraped daily. The pans are cleaned up at the end of each month and when putting on new shoes and dies. The mortar boxes are also cleaned out at the end of each month and from time to time when boxes are opened and dies, etc., attended to. A Berdan pan is provided for the clean-up of amalgam and other rich material.

The amalgam is retorted in shallow iron trays placed in a bricked-in retort. The bullion is smelted in a circular wind furnace and cast into bars.

The gold recovered by amalgamation has an average value of about 81s. per oz. For precipitation of gold solution from the cyanide treatment, three zinc extractor boxes are provided, only two of which are in use. Each box has nine compartments 3 ft. 6 in. by 2 ft. by 1 ft. 6 in. Only eight compartments are used in each box. The boxes are dressed and attended to every week and thoroughly cleaned up once a month.

The usual procedure of aciding, washing, filtering, drying, roasting and smelting is carried out.

The drying and roasting is done in a reverberatory furnace capable of holding two wrought-iron trays, each of 150 lb.

moist-slime capacity. The roasted slime is smelted in a tilting furnace. Bullion having an average value of about 65s. per oz.

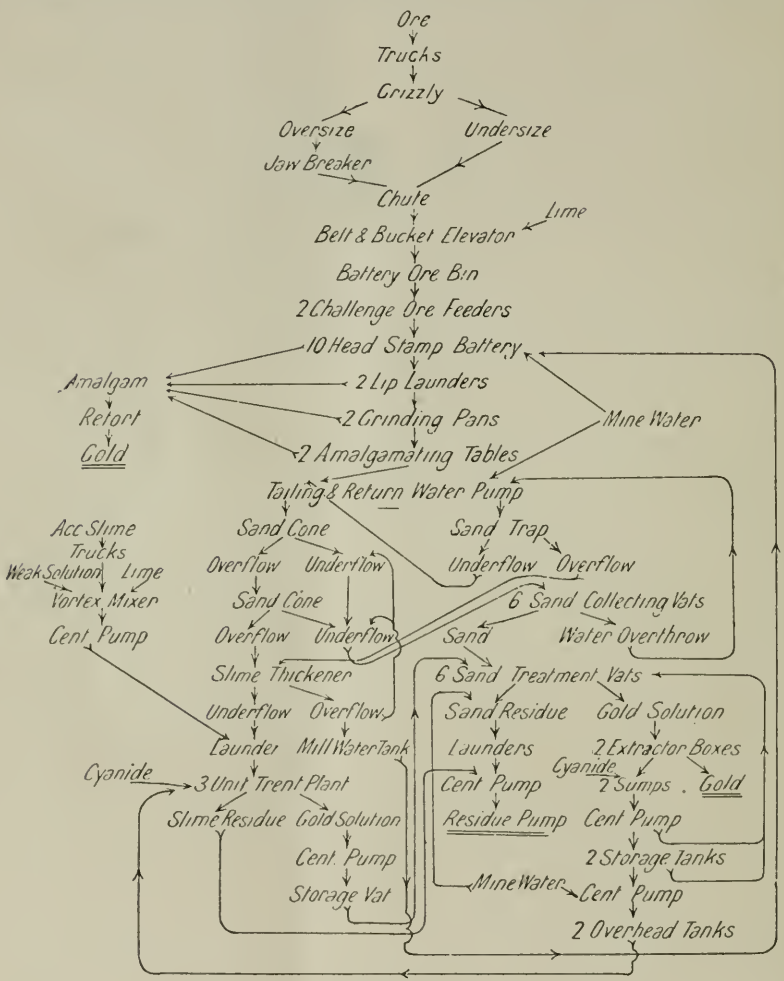

FIG. 1.

FLOW SHEET, EDNA MAY GOLD MINING CO. N.L.

is produced. The flow sheet (Fig. 1) represents the present circuit of treatment operations.

NOTES ON CORNISH MINING PRACTICE.

By the late W. F. McBryde Broun.

William Frederick McBryde Broun, a graduate of the Royal School of Mines, was employed on the staff of the Mount Morgan Gold Mining Company for some years prior to 1912, and will perhaps be remembered by some of those who attended the Mount Morgan meeting of the Institute in 1910, as an Associate Member present on that occasion. He severed his connection with the Mount Morgan Company in 1912, and was returning to England via the East Indies, when he contracted typhoid at Singapore and died at Colombo.

Years later some old papers were being turned out in the office where he had worked. when a set of M.S. notes in his unmistakeable handwriting came to light. On examination these appeared to be the rough draft of a paper he must have been preparing for the local branch of the Institute, which he had not been able to complete. The notes were very rough. Apparently it was the author's intention to fill in numerous gaps with extracts from sundry published articles on Cornish mining; the extracts were missing and only the written portions linking them together were there. They give a sketch of Cornish mining practice which those who wish may supplement (as the author would have done) from Le Neve Foster and other well-known sources. The fragmental notes which have been pieced together as carefully as possible by Mr. B. G. Patterson, Hon. Secretary Mount Morgan Branch, are as follows:—

The first mine the author worked at was Carn Brea, in 1904. This is one of the largest tin mines in Cornwall, and belongs to the Carn Brea and Tincroft Mining Co., which also owns Cooks Kitchen. The mine was started in 1832, but had been in a bad way for several years previously, and had just begun to recover

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itself owing to the increased price of tin. It is situated halfway between Redruth and Camborne, a mile and a half from either place. The sea is about six miles to the north.

There are two principal lodes, which—like practically all the Cornish tin lodes—run east and west. These two lodes are known as Highburrow East and Highburrow West, which are also the names of the two principal shafts sunk on them. Highburrow East is the shaft with the largest skip road in Cornwall, the distance between the guides being 3 ft. The shaft is vertical for 90 fathoms. (All Cornish mining measurements are expressed in fathoms.) After descending 90 fathoms the shaft inclines to the south at about 70°, and varying at times slightly to the vertical and horizontal, according to the dip of the lode, reaches a total depth of over 2000 ft. The guides in use were 4 in. x 4 in. timber with a flat strip of iron on the side where the wheels of the cage and skip run. The shaft, which is practically in solid granite, has very little timber—the skip guides being bolted to cross pieces fixed between the hanging and foot-walls by hitches. The ladders run alongside the skip road and are generally fastened to the other side of the cross pieces. The pumping beam also is close to the skip road and generally about 2 ft. out from the ladder, which makes one keep any projecting part of the body remarkably close to the ladder for fear of being caught on a nut.

The cage or "gig", as it is called, is a two-deck affair with the back and two sides closed in and with a small opening in the front. The lower compartment is not 6 ft. high, which makes it rather awkward for tall men, as when closely packed there is not room to bend. An iron bar runs vertically through the middle of both compartments. The gig has four wheels, two on each side, and also a flat iron bar across the back projecting at each side behind the guides to keep the gig from jumping off. The roof of the upper compartment is slightly rounded, making it a little over 6 ft. in height. The gig is 2 ft. 11 in. in width and 3 ft. 6 in. in breadth, and takes 18 men when full—nine men in each compartment—the last man getting in has to

curl round the legs of the other eight, there being no room to stand. The author has frequently been in cages so tightly packed that on arriving at the surface, or "on grass" as the Cornishman puts it, the braceman—or "lander"—and his mate have to haul the first man out by main force, it being quite impossible to move unaided. Needless to say, there is not the same crowding when going to work.

Chains are attached to the four corners of the roof, and thence to a shackle, the bolt of which is secured by a pin, easy to remove. To the shackle is attached the winding rope. At 90 fathoms down—the bottom of the vertical portion of the shaft—is the adit through which the water that is pumped up from the mine flows out. At Carn Brea, and at most Cornish mines, the depths of the various working levels are always measured from the adit level. Thus, for instance, the 170-fathom level is really 260 fathoms from the surface.

The skip held about 1½ tons. In width and breadth it was the same as the gig, and about 7 ft. long in front. A door was placed on the bottom half of the front. To load the skip, chains were first fastened across the skip road as chairs. This had to be done by hand, hooking the chains, of which there were always two, to hooks on the opposite side of the shaft. When the skip was at rest on these, wings, consisting of iron sheets, were turned down on to the sides of the skip to prevent pieces of ore from falling down the shaft. The trucks, which held about 7 cwt., were then tipped in, and, there being only a single line of rails, they were run back a little and thrown off as soon as they were tipped to make room for the next. About four trucks went to the filling of a skip, and 15 skip loads were all that were ever pulled in a shift, the miners after that going "back shaft" to wait for the gig.

While the author was working there most of the ore was being pulled from the 170-fathom level. After the shift had been lowered the gig was hauled up and changed with the skip in the following manner. The guides were continued for some distance above the surface, and a section of them, slightly longer

than the cage, fixed to a vertical post socketed top and bottom. At right angles to this section, another section of guides is fixed so that they can be swung round to take the place of the former. Chains and hooks are also fixed to the top of the post. . . . . .

The pumping engine for Highburrow East shaft is one of the largest in Cornwall. . . . . .

Balance boxes, of which there are four altogether, are placed, one at the surface and the others at intervals down the shaft—one at 90 fathoms, one at 160 fathoms, and one lower down. The one at the surface is the largest and is about 10 ft. sq. and 6 ft. deep. They are all filled with granite. . . . . .

Underhand stoping is employed almost entirely. At that time very few rock drills were used and these only for driving. The stoping was all done by hand, a boy generally holding the drill and two men beating. The miners seemed to think that the man who made the most noise was the hardest hitter, and consequently a stope with about 20 men drilling sounded like a shipload of seasick people.

The ore is carried in wheelbarrows to the chutes, and thence down to the main drive where it is trucked to the skip.

The miners are the first to be lowered always ; the timbermen staying on top to cut the timber they want. Ordinary axes, known as "dags," are used, instead of the adzes such as are used in Australia. The shaftsmen, whose duty it is to walk down to the bottom of the shaft examining the shaft timber and also the pump as they go along, if there is nothing to be done in the way of repairs, get down to the bottom in two hours or so and then sleep until the gig comes for them, when they have the advantage of the others in that the men from the lowest levels are pulled up first. The shafts being generally cold and wet the shaftsmen always wear under-shirts made of blanket, and their canvas coats are lined with blanket. All the men, from the mine manager downwards, invariably wear the regular Cornish miners' hat. This is made of felt dipped in resin, and is worn over a tight-fitting skull cap. The hat is in the shape of a bowler

(*alias* "hard hitter" or "peewee") with a rather flat brim and is very comfortable when one becomes accustomed to its weight.

Candles are the only means of lighting employed, and the old-fashioned "farthing dip" is always used. These go about 12 to the lb. and have twelve wicks joined together at the top in the form of a loop. Each man takes six or eight down for a shift, with a piece of string passing through the loops of the wicks and hitched on to a special button on his coat at his side. These candles require clay round them right up to the top—they are usually carried on the hat where a reserve of clay is also stowed.

The shift bossess or underground captains always don a clean suit of clothes every day, and these suits, being made of white canvas, are a great help to the miner in letting him know when the boss is coming.

The contractors employed at that time were known as tributors, and were generally old men with much experience in mining. They were paid so much a ton for the black tin extracted from the ore they sent out, and therefore followed the rich bits of the lode about, which usually resulted in a drive which was not straight anywhere for as much as six feet. These old tributors generally preferred working on their own, and the author remembers seeing one old man putting down a winze on his own; when he had filled the bucket he had to climb up about 25 ft. and empty it and then down again, wasting most of his time climbing up and down rather than have a mate. . . . . .

Wolfram about this time (August, 1904) was worth £310 a ton, having risen from £30 in three years. . . . . .

From January to June, 1904, Carn Brea and Tincroft crushed 24,745 tons of ore, of an average value of 17s. 10·18d.—the average value of black tin being £69 9s. 3d. The total receipts were £24,755 19s. 11d., and the working costs £28,417 3s. 8d. . . .

Papers and Discussions.

CONTENTS.

PAPERS—

Page

Notes on the S. and M. Mine and on Treatment of Bismuth, Tin and Wolfram Ores (with 1 Fig.). By Wm. E. Hitchcock and J. R. Pound - 33

NOTES ON THE S. AND M. MINE AND ON TREATMENT OF BISMUTH, TIN, AND WOLFRAM ORES.

By Wm. E. Hitchcock and J. R. Pound.

General.

This mine, which is the property of the S. and M. Syndicate, London, is located at Moina, in North-West Tasmania, 18 miles from Staverton railway station and 36 miles from Devonport. There are metalled roads from both of these places, and, although hilly, these are good for team or motor traffic. Mails and passengers are provided for by a tri-weekly coach service from Sheffield, a railway town, distant 23 miles. The Moina mining field is situated on a main spur between the Forth and Iris Rivers, and at an elevation ranging from about 500 ft. above sea-level at the Forth River to 2400 ft. at the All Nations mine. The elevation at the mine office of the S. and M. mine is 1900 ft. The average annual rainfall, as recorded for the past eight years, is 68 in. This includes, however, a couple of years during which the rainfall was much above normal, and, taken over a longer period, 60 in. would be nearer the average.

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In common with the inland districts of North-West Tasmania, the country facing from the high interior table-lands is much broken by deep river gorges, thus confining the main roads to the spurs between these gorges. Much of this district is covered with basalt, and, except when cleared, carries a dense growth of timber and scrub. In many places, however, various exposures of the mineral-bearing rocks are to be seen. Those in the vicinity of the S. and M. mine are granite, porphyry, quartzite, conglomerate, a lime-silicate rock (locally called garnet), and limestone. The geology of the district has been fully dealt with in various Tasmanian Geological Survey publications, the most recent being the following :—

Bulletin No. 14, "The Middlesex and Mount Claude Mining Field," by W. H. Twelvetrees, Government Geologist (1913).

"Mineral Resources," No. 1, Part II., "Tungsten and Molybdenum," by Loftus Hills, M.Sc., Assistant Government Geologist (1916).

Bulletin No. 29, "The Mining Fields of Moina, Mount Claude, and Lorinna," by A. McIntosh Reid, Assistant Government Geologist (1919).

Geology.

The writers are indebted to Mr. Twelvetrees, Tasmanian Government Geologist, for the following notes on the geology of the district :—

"The tin-wolfram lodes at Moina are a complex of veins traversing beds of sandstone or quartzite and lime-silicate rock. These rocks form a contact metamorphic aureole surrounding a mass of granite and granite-porphyry which is exposed further east and south for a width of between two and three miles, and for about a mile from north to south. This exposure of granite represents one of the many uprisings of acidic magma which occurred in different parts of Tasmania during the Devonian period.

"The age of the sedimentary beds intersected by the lodes has a range which is taken to extend through the Lower and Middle

Silurian. The limestone at the Iris bridge is considered to be well down in the Silurian, while the pipe-stem sandstone which underlies it cannot as yet be placed with absolute certainty, but is probably either Lower Silurian or Upper Ordovician. Next in age below the sandstone come the conglomerates on Stormont and Black Bluff and the conglomerate crags near the road at Bell Mount. These were considered by Mr. G. A. Waller to form the base of the Silurian system, and the occurrences near Zeehan would seem to support his view. A definitive conclusion, however, has not yet been arrived at. Geologically below the conglomerate is a series of slates and porphyrites which are exposed by the road-cutting round Bell Mount, and some porphyroids or dynamically metamorphosed quartz-porphyries up the Iris River at the base of Stormont. This series is in all likelihood Ordovician. In the absence of organic remains it is hazardous to correlate such rocks with their supposed European equivalents.

"The occurrence of the lime–silicate rock at the S. and M. mine points to the alteration of original limestone within the zone of contact–metamorphism. The rock consists of magnetite, fluor, garnet, and vesuvianite, with epidote and veins of pink felspar. The contact metamorphic minerals are, on the other hand, absent from the mineral lodes in this rock. The lode gangue consists mainly of quartz, topaz, fluor, and mica. Its structure is pegmatitic, and the tin, wolfram, bismuth, and molybdenum ores are pneumatolytic in nature and origin. A fresh-coloured, friable mineral occurring in one of the lodes was at one time supposed to be stilbite, but has lately been determined as laumontite. During the test, which was carried out by the Geological Survey of Canada, traces of mercury were detected. The occurrence of this zeolite in the lode is interesting; it may possibly have been derived from percolation from the Tertiary basalt which is believed once to have covered the surface.

"While the Moina lodes at the S. and M. mine, the All Nations mine, and the Tin Spur mine are in sandstone or quartzite, those on the Squib, Dolcoath, Sayers', and Urquhart's properties are in granite rock.

"The economic minerals at Moina may be considered as having had their source in the granite magma. The pegmatitic veins both in the granite and the surrounding aureole harbour ores of tin,

tungsten, bismuth, and molybdenum, indicating deposition from metal-bearing, igneous emanations. At a greater distance from the granite boundaries the metallic vapours were replaced by magmatic waters in an outer hydatogenic zone, giving rise to the deposition of galena and zinc-blende—*e.g.*, at Wilmot River, Lea River, Five-Mile Rise, etc.

" At the bridge over Bismuth Creek, at Moina, basaltic agglomerate and tuffs are seen ascending above the roadway, and descending into the creek. The exposed cliffs have a somewhat knobby surface, and further up the road pieces of volcanic glass occur in a fragmentary matrix. This all points to showers of tuffaceous material. An explosive vent must exist somewhere in the vicinity. The varieties of lava range from pure tachylyte to normal olivine-basalt. The age of this eruptive rock is Tertiary, and the occurrences at Moina are part of the basaltic sheet which covers a good deal of this part of the country and has produced a soil remarkable for its fertility."

The Mine.

At the S. and M. mine 5 lodes are worked. Those known as Nos. 2, 4, 5, and 6 have a nearly parallel course E. and W.; but the N.W. lode, as its name implies, has a N.W. and S.E. course. They are nearly vertical, the underlay, excepting that of the latter, which is to the N.E., being to the south. The distances apart, widths, and lengths worked are :—

Lode.	Distance from No. 2.	Average width.	Length worked.
No. 2	—	10 in.	780 ft.
No. 4	165 ft.	15 ,,	1400 ,,
No. 5	275 ,,	8 ,,	300 ,,
No. 6	735 ,,	20 ,,	750 ,,
N.W.	735 ,,	15 ,,	400 ,,

A striking feature is the persistency of the lodes in length and the fairly uniform widths. Bulges or pinches do not occur, but the lodes frequently split into veins, the aggregate widths of which are usually that of the lodes where solid. Nearing the lateral limits the lodes become reduced in size, and usually split up into small veins. The gangue consists of quartz accompanied

by fluorite, mica, and topaz, and the minerals are cassiterite, wolfram, scheelite, bismuthinite, bismutite, and pyrite. Chalcopyrite and molybdenite also occur sparingly, and galena has been noted. The rocks, quartzite and garnet, have a strike N. and S., with a dip to the west. The lodes traverse these at right-angles to the strike, and pass from the quartzite to the overlying garnet without change. A faulting of some 3 ft. occurs at the contact, which dips about 50° to the west. The values do not occur in shoots, but are irregularly distributed, and it is consequently necessary to take out the whole length of the lodes to avoid missing the richer patches, of which there is usually no indication until they are met. The lodes have no walls, and, as there is no dig or fluccan, cannot be broken down separately. It is therefore necessary to break the country-rock on each side to the working width of drive or stope. A disadvantage exists in that a considerable amount of waste rock is mixed with the ore, and this especially when the lodes split into veins which separate over a width of several feet. Basalt covers the western portions of the lease to the extent of nearly two-thirds of the area (320 acres), but fortunately the quartzite and garnet rocks show up along the eastern boundaries, thus enabling the lode outcrops to be picked up and followed under the basalt.

At present the greatest depth of the workings from the surface is 300 ft., and the lodes at this depth, as compared with those at the surface, do not show any very serious lowering in values in cassiterite and wolfram. The bismuth values, however, do show a reduction, as the richer patches were met with near the surface. Some of these patches yielded as much as a couple of tons of carbonate of bismuth.

The lodes are worked by adits and from a main shaft. No. 3 adit, which is the lowest, has been driven in a S.E. direction for 1230 ft., cutting No. 6 lode at 390 ft., No. 5 at 925 ft., No. 4 at 1050 ft., and No. 2 at 1215 ft. This adit is the main outlet to the mill. The main shaft has been sunk to the present depth of 171 ft. below No. 3 adit from a chamber adjacent to the intersection of No. 6 lode, and the shaft was also risen through to the

surface, a distance of 96 ft. The main shaft is 11 ft. 6 in. x 4 ft. inside timbers, and is divided into three compartments, of which two are used for hoisting and a third for ladders and pump-way. Hoisting is done mainly by an air-winch located at No. 3 adit, to which level the ore is raised and trammed to the mill on trucks of 11 cub. ft. capacity. At the surface a second winch and head-gear have been installed, and as an alternative this plant is used, under steam, during shortage of water for power. In this event the ore is hoisted to the surface and sent to a dump of a capacity of 1000 tons, whence it can be drawn off, through a pass, to No. 3 adit level, as required. This is useful especially when milling has to be suspended owing to dry periods or repairs, and enables development work, at least, to be carried on independent of milling.

Methods of Mining.

The methods adopted in development work and ore-breaking are as follows :—

Levels are driven along the lodes for convenient lengths, say 200 to 300 ft. The boring is done with $2\frac{3}{4}$-in. Holman reciprocating machines rigged on upright bars with cross-arms ; and $1\frac{1}{8}$-in. octagon steel, with chisel bits, is used for drills. Where practicable two ends are driven alternately by the machine men, who, after boring out one end, shift to another, and whilst they are engaged in boring the second the first is fired out and cleaned up. The advantage of this is that ample time is available for firing out and clearing up, and, what is most important, the boring machine is kept going. This makes for more even and regular air-consumption, and enables the most to be obtained from a limited air supply. When the level has been driven for the required distance, a start is made from the end to bore the back of the level. For this purpose telescope hammer drills are used, operating from the floor of the level, and the temporary air and water pipes are taken off as boring progresses. "Uppers" 4 ft. in height are bored, spaced about 2 ft. 6 in. apart, and staggered on each side of the lode. Firing-out closely follows the boring, and

a second "cut" of 4 ft. in height is bored and fired. The broken ore is left on the floor of the level until the whole length is broken down to a height of about 15 ft. above the rails. The back of the stope is left bored out for its whole length, and, these operations being completed, a start is made to truck away the ore. As the ore is removed it is followed up closely by the timbering, and the waste rock, as hand-picked out, is thrown back on top of the timber. Chutes and man-ways are formed, and a minimum depth of 2 ft. of filling is stowed on the back laths. Shovelling boards are laid on top of this filling, which has first been covered with a layer of sacking to avoid loss of fine ore in the interstices of the coarse filling. The reason for boring out the back of stope is that there is not sufficient room to operate the machines between the filling and the back of the stope when stoping is re-started. The filling is to protect the timber, and it is also usual, to avoid breakage of caps or stulls, to put in a temporary centre leg. This precaution has been found necessary, as occasionally the force of a blast will be downwards, and in such instances the filling does not always save breakage. The timber used is 7 in. x 7 in. split hardwood lagged with 6 in. x 1½ in. split laths. The caps or stulls are hitched into the walls, and supported by one or two legs, according to the span or circumstance. The objective, however, is to have the stulls or caps independent, as far as possible, of the legs, although these are put in. This is useful in taking out the last stope of the level below, and facilitates the picking up of timbers during that work. In the stoping operations one or more machines are set to work to bore out the back of the stope for its whole length, which may be 300 ft. or more. This being completed, the machines are moved to another stope, and firing-out is done in several sections along the first stope. After two 4-ft. cuts are broken down the waste rock is hand-picked and the ore is shovelled into passes.

Cruciform steel (1¼ in.) was at first used for the telescope drills, and much breakage of steels was experienced. This frequently happened not only at the bit, or shank, but in the middle of the

drill. Various qualities of steel were tried without any appreciable difference. Annealing gave very little relief, and, as an experiment, shanks and bits were welded on to 1-in. round iron. After three or four weeks breakages occurred in the same manner, and it appeared that the rapid blows caused a crystallization of the metal. However, by using $1\frac{1}{8}$-in. octagon steel the breakages were reduced to a minimum, and were confined to shanks and bits.

The wear on hammer drill parts is very heavy, and the anvil blocks especially have a short life. The rock, however, is very hard, and it appears that the limit of endurance of hammer drills is here nearly reached. The air-pressure at receiver is 100 lb., and, as the air pipes are of liberal dimensions, a good pressure is behind the drill. For air and water are used special hoses made by the Dunlop Rubber Co. These differ from the ordinary 6-ply marline or cotton-covered hoses in that they are covered with a coating of tough rubber, $\frac{1}{8}$-in. in thickness, in place of the usual marline or cotton. This rubber covering has been found to resist abrasion very well. As a matter of fact, the first hose of this class put into use was underground for 25 months without being brought to the surface, and after 36 months it is still in use under air-pressure. A marline cover would require to be renewed, under ordinary conditions, every five or six months, and, as the first cost is about the same for both classes of hose, a considerable saving in favour of the rubber cover is shown. Also, the water and grit do not adhere to the rubber-covered hose as to marline or cotton-covered ones. The rubber hose is usually coiled and carried, whilst a marline-covered hose, with its load of water and grit, is dragged from place to place, with consequent damage to covering and fittings. Water-jets are used with all machines. For the telescope machines a miniature column made of 1-in. piping, with a sliding claw and with a suitable clamp for holding and directing the nozzle, is used. This is so arranged that the operator can easily adjust the direction of the jet, and, as the telescopes are essentially one-man drills, the necessity of having a second man to hold or direct the jet is

avoided. In order to encourage the free use of water when boring, and as such water tends to damp the drill operator, the men on the telescope drills receive "wet" pay.

The machine-men, both on Holman and telescope machines, do not usually fire-out, but as far as practicable are engaged for their whole time in boring. Those engaged in firing-out usually attend to several places in rotation, and ample time is thus available for the smoke to clear. These methods, however, require a number of "ends," and that the development work for the stopes shall be kept well ahead. If this happy position is permissible and obtained, the advantages in working are very great. Owing to the narrow widths of the lodes, and to the large proportion of waste rock to be sorted out, rill stoping is out of the question under present conditions. The amount of waste rock does not suffice for filling, and this is supplemented from other sources; but if such is not available, stulling is put in and another start made above. The rock is good for standing, and there is no side weight or pressure. It is probable, however, that, as the workings at the shaft levels become more extensive, rill stoping will be resorted to, and the whole of the dirt will be sent to the surface, where sorting can be done on a picking table or belt and the waste rock sent down through passes to the stopes for filling. The underground work is all done on wages, and no contracting is at present in vogue.

Mine Drainage.

The water required to be pumped from the shaft levels amounts approximately to 2500 gal. per hour. For a considerable time the water was pumped at intervals as required by vertical air-driven pumps of outside-packed plunger type. These, however, were very wasteful of air, and the efficiency, therefore, was very low. In order to utilize the hydraulic power to better advantage, a water-power-driven plant was constructed in the following way:—The pumps having a common stroke of 12 in., the water ends were utilized, the air cylinders being removed. Oregon rods, 4 in. x 4 in., were put in from the adit level to the pumps, a depth

of 150 ft., and connected to the pump plungers in balance. On top a heavy crank shaft, formerly used on a double-cylinder portable engine, was placed across the shaft. To give the balance the cranks were bent from the old angle of 90° to 180°. The connecting rods from the same engine were utilized, and, in order to minimize side-thrust, were lengthened to 10-ft. centres, and used to connect the oregon rods to the crank shaft. Suitable guides, at intervals, were put in the shaft to steady the rods. The crank shaft is driven by spur gear from a countershaft, which in turn is driven by belt gear from an 18-in. Pelton wheel. The power water is conveyed by a branch from the main pipe line to the plant, which is located underground in No. 3 adit. The head is 350 ft. A $\frac{7}{16}$-in. nozzle is used, this being the limiting size which, under the circumstances, it is advisable to use, on account of the danger of leaves, etc., passing through the pipes and blocking the nozzle. The speed is adjusted by a deflecting shield, which cuts off part of the jet. Although this may appear wasteful, the total amount of water used for this power is not large, and the saving which would result by using a smaller nozzle, or needle valve, is a small consideration, especially when the water would run to waste for the bulk of the year.

The pumps run at between 13 and 14 revolutions of crank shaft, and, as the pumps are double-acting, the number of strokes are between 26 and 28 per min. Both pumps were originally designed as steam or air direct-driven pumps for 100 strokes. It has not been necessary to approach anything like this speed with the present arrangements and amount of drainage, but, under a positive drive, a speed of about 70 strokes appears to be the limit of smooth and safe working. The pumps run constantly and are capable of very close regulation. It is usual to allow them to run for periods extending over 12 to 15 hours without any attention whatever, and they can be so adjusted that after that time there is practically no alteration in speed, and no difference in the water-level in the sump. Oil reservoirs with chain slings are used on all bearings, and the whole plant is designed with a view to cutting out any attention during afternoon and

night shifts. It has in this respect exceeded expectations. As a stand-by baling tanks of a capacity of 250 gal. each are used.

The Mill.

In considering the mill flow sheet (fig. 1), the nature of this ore requires some little explanation. The lodes consist mainly of quartz of a fairly friable nature, enclosed in rocks which are hard. The minerals are easily freed from the gangue, and probably 60 to 70 % is already freed before reaching the mill. The wolframite and bismuthinite occur in "lumps" and "patches," and the cassiterite in coarse grains up to ½ in. or more in diameter. After the ore has passed through the rock-breaker very little remains to be freed, and after reduction by the rolls to a maximum of ½ in. diameter, practically the whole of the balance is liberated. Thus, reduction does not enter very largely into the process. The country-rock, especially the quartzite, contains fine grains of pyrite disseminated through it, and the garnet rock contains much magnetite. The objective, therefore, is to liberate the valuable minerals and as little as possible of the impurities.

The concentrates from all machines in the mill are produced in two grades—namely, "firsts" and "seconds". The objective with regard to the "firsts" is to retain all the valuable minerals, but to reject the pyrite and silica, and with the "seconds" to retain the pyrite and reject the silica as far as practicable. By making a "seconds" product it is possible to aim at a clean "firsts" product which is practically free from pyrite and magnetite.

The percentages of contents of "firsts" and of "seconds" are approximately as follows :—

"Firsts"	%	"Seconds"	%
Sn	35	Sn	12
WO_3	35	WO_3	10
Bi	2.5	Bi	3.5
Total ..	72.5	Total ..	25.5

With the large amount of magnetite which occurs in the inseparable country-rock in the mill dirt, any attempt to obtain

clean "firsts" only must result in loss. A "seconds" product retaining the pyrite and a considerable amount of magnetite is therefore made—not that the pyrite and magnetite are of value, but because they cannot be rejected in wet concentration without loss of metal. The treatment of these concentrates by a magnetic separation plant at Launceston will be dealt with later.

It is proposed, however, to instal at the mill a magnetic separator for the removal of magnetite, and in this event to take a lower grade "seconds" concentrate which, after removal of magnetite, will be re-dressed to a clean concentrate of "metal" and pyrite. After removal of the magnetite the disposal of the silica will not be a very difficult matter.

Details of the Milling.

The ore from the mine is treated by a wet concentration mill. Formerly this consisted of a rock-breaker, stamps, hydraulic classifiers, jigs, and vanners. As the minerals are mostly coarse, and as stamping is fatal to such minerals as wolfram and bismuthinite, an effort was made to improve matters by sizing and jigging the product from the breaker before stamping. This was then passed through a trommel with ½-in. and 1-in. holes. The over-size went to a bin, from which the stamps were fed by Challenge feeders, and the under-sizes were fed to respective jigs, from which the tails went direct to the stamps. This feed was constant, and the deficiency was made up from the over-size bin by the self-feeders. In practice this over-size rather more than made up the deficiency of feed from the jig tails, and it was usually necessary to crush out the over-size remaining in the bin after jigging was stopped.

The concentrates from these jigs, taken from sieves and hutches, represented over 75 % of the total obtained, but, being poorly sized, required much dressing to bring to a marketable standard. Shortly after operations were started by the present owners in 1906 it was decided to remodel the mill. Rolls, trommels, additional jigs and Wilfleys were installed, and the stamps were hung up. Unfortunately, at the time it was considered advisable

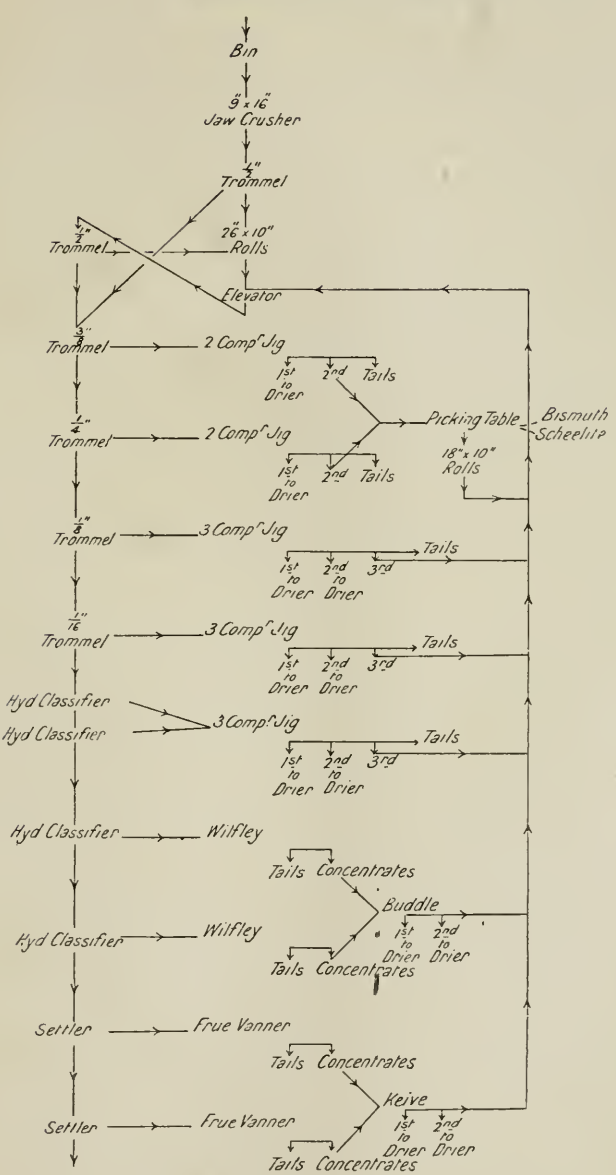


FIG. 1.

FLOW SHEET, S. & M. SYNDICATE, MOINA, TAS.

not to take out the stamps, but to retain them for treating jig tails, and, like the snail in the beehive, they had to be built around, thus affecting to a large extent the arrangement of the altered mill.

After the mill was remodelled, tests made in reducing the jig tails by stamps gave such a foul concentrate of low value that this treatment was discarded. The efficiency of the jigs was improved, and it was decided to stop reduction at a $\frac{1}{2}$-in. maximum. There has to be considered not what can be recovered, but what, as a business proposition, it pays to take out. At some of the smaller "shows" in the district it is usual to treat the ore by sluicing in boxes. A rough concentrate is obtained, which is sieved to various sizes and dressed up by hand. Any lumps containing mineral are thrown to one side and knapped. In this way a fairly good extraction is obtained, and, what is important to the co-operative parties who own these "shows," capital expenditure is avoided, although a good deal of hand work is involved.

Now, reverting to the mill flow sheet, it will be seen that the first step is reduction by a rock-breaker. The ore is hand-fed to this machine, and the feeding is regulated by the capacity of the mill, or, vice versa, the rate of feeding regulates the amount milled. The capacity of the mill is 4 tons (of 22 cub. ft.) per hour, and the feeding of this is, with good facilities, quite within the powers of a strong lad. In addition, the feeder picks out from the ore any pieces of steel.

It is proposed to instal a bin between the breaker and the rest of the mill, and to use a mechanical feeder. Some little difficulty, however, exists in that such a course will necessitate the breaker being run "dry," and, as a proportion of the ore is wet, very probably a tendency to clog in the breaker will occur. The main advantages will be in regular feeding (which, however, will have to be adjusted to suit the different classes of ore), and in having the breaker as a separate unit, the stoppage of which will not involve the stoppage of the mill. The breaker is of the Blake type, the jaw opening being 9 in. x 16 in. Manganese steel liners

of hollow pattern are used. The pitch of the teeth has been reduced to $\frac{3}{4}$ in., and it is proposed to further reduce this to $\frac{1}{2}$ in. in the lower sections. For filling the hollow backs, red beech (locally called "myrtle") is used; this wood answers very well and saves the time and cost of filling with scrap and spelter. To prevent damage to the jaw seats a $\frac{1}{2}$-in. steel plate is placed between the jaw and seating. Some time ago a difficulty was experienced in keeping down the size of the product and in the increase of power required. This was due to excessive stroke caused by increased angle of the toggle plates, and the remedy was to lower the toggle pads on the swing jaw and bolster block, and to raise those on the pitman. The effect was to "flatten" the toggles, and immediate relief was obtained in lessening the power required and in keeping down the maximum size of product to 1 in. The angle of the toggles regulates the stroke: for instance, if the toggles were flat there would be practically no stroke. After breakers of this type have been in use for some years the wear on toggle pads, pitman bearings, and eccentric shaft bearings, although slight, tends to increase the angle of the toggles. This effect is gradual, but after a certain stage increases rapidly, and then, if not remedied, not only is it difficult to keep down the size of the product, but, as with the increased stroke more work is put on the lower part of the jaw, the strain on the machine increases enormously. Further troubles come in. such as increase of power required, breakages of pitman and of swing jaw, and bending of eccentric shaft. The breaker is driven by a 36-in. Pelton wheel under a head of 375 ft. The nozzle used is $\frac{1}{2}$-in. diam. for a $\frac{3}{4}$-in. stroke and $\frac{9}{16}$-in. diam. for a $\frac{7}{8}$-in. stroke. It must be understood that the stroke referred to is the movement of the lowest extremity of the swing jaw, and not that of the pitman The breaker is set to run at 275 r.p.m.; but the speed can be regulated by the feeder to suit the different ores by means of a lever connected with a deflecting shield attached to the nozzle. This shield, at will, deflects part or the whole of the jet; such regulation is preferable to throttling by an adjustable nozzle or valve for this class of work.

From the breaker the ore, assisted by water jets, passes to a conical trommel 4 ft. 6 in. long and of 24 in. to 33 in. diam. The screens are punched with $\frac{1}{2}$-in. round holes, and the revs. are 20 per min. The under-size passes to a series of trommels and the over-size to the rolls. The rolls are 26-in. diam. by 10-in. face, and are gear-driven at 35 r.p.m. As originally obtained, the roll shells consisted of one plain, 10 in. wide, and one flanged, $12\frac{5}{8}$ in. wide. The flanges were originally 1 in. in depth, and the life of the shell was limited to the time until these came in contact with the segment bolts of the opposite roll. To remedy this the flanges were discarded, but the shell kept to the former width of $12\frac{5}{8}$ in.; this enabled the shells to be worn down to the limits required by the gears before being replaced. With the advanced cost of shells it was found economical to have a number of old shells machined-up and again used. As the rolls are gear-driven, and as the lesser diameters of the worn shells brought the centres too near for the safe working of the gears, one of the shafts was disconnected at the "wobbler" and the roll on that shaft was driven by friction. This was satisfactory under the circumstances, especially considering the high cost of renewals. It was only possible to utilize the plain shells, as too much machining was involved in cutting off the flanges which formed on the wide shells. In order to lessen the thickness of shells discarded, and to retain the gears, it is now proposed to increase the diameters of the roll bosses, and also to increase the inside and outside diameters of the shells. The rolls were evidently designed for hard-iron shells, which did not permit of wearing down to the degree of thickness permissible in the chrome-steel shells which are now used. Hard-iron shells were discarded in favour of those of chrome steel, the comparative life being 2800 mill tons for hard iron against 5500 tons for steel. The hard-iron shells also wore badly and reduced the efficiency of the rolls. As the shells wear, the tendency is to become grooved; this is avoided as much as possible by distributing the feed. The rolls are run in contact with rubber buffers for tension. The tension is adjusted to suit; and here it is found advisable to allow a little

latitude in order to avoid damage from pieces of steel bits which find their way to the feed.

From the rolls the ore is raised by a bucket elevator to a cylindrical trommel 22½ in. in diameter by 6 ft. long, the screen of which is punched with ½-in. holes. The over-size from this trommel returns to the rolls and the under-size to the next trommel. It may not be good practice to return this over-size to the same rolls, but, as the capacity of the rolls is ample, a second pair in a mill of this size is not justified. The next trommel is 8 ft. in length, 22½ in. in diam., and has screens, each 4 ft. long, in tandem, punched with ¼-in. and ⅜-in. holes respectively, and in that order. The under-size of the ¼-in. goes to the next following trommel, and the under-size and over-size of the ⅜-in. trommel feeds respective jigs. These jigs yield products from sieves through gate discharges and from hutches. From the gates from the first compartment the products consist of "firsts" concentrates; these are hand-picked for bismuth ore and for scheelite, and are then bagged as "firsts." From the gates from the second compartment the concentrates, after hand-picking for bismuth ore and scheelite, are passed through a pair of 18-in. x 10-in. rolls and are then returned to the mill circuit. From the hutches of the first compartment is obtained a product which, after hand-sieving, is good enough for "firsts"; and from the hutches of the second compartment is obtained a product that either is made good enough for "seconds" by the same process or is returned to the mill circuit.

Again, the sizes from the ⅛-in. and $\frac{1}{16}$-in. trommels are fed to suitable jigs, and the under-size from the $\frac{1}{16}$-in. passes to a pair of hydraulic classifiers. It is found preferable to divide the feed to two classifiers in place of one large one. Spigot discharges from these classifiers provide feed for a fine jig. These jigs have three working compartments, each with screens 36 in. x 18 in.; "firsts" are obtained as a product from the first hutch, "seconds" from the second hutch, and the product from the third hutch is fed again to the mill circuit. The third hutch is regarded as a stand-by in cases where the adjustment of the jig

or bedding is interfered with by a rush of feed or mineral. The first and second hutch products (except from the fine jig, which yields a clean product) are hand-sieved to remove a little fine sand, and are then clean enough to dry and bag. By careful adjustment of the jigs, the scheelite was passed as much as possible into the "seconds"; and the "seconds" contain, as a rule, more bismuth than the "firsts." The jigs, which are of the ordinary Hartz type, were constructed of "celery-top" pine, cut at the mine saw-bench. This timber, which is almost without shrinkage and has excellent lasting qualities, serves admirably for this purpose. The eccentrics are adjustable, and enable the stroke to be altered if necessary. It is necessary to attend carefully to the adjustment of the jigs in stroke, bedding, and water supply. The bedding or ragging particularly requires attention on account of the varying contents of the ore. The overflow from the hydraulic classifiers passes to two Rittinger classifiers, from which the spigots feed respective Wilfley tables, and the overflow goes to a two-compartment settler. The concentrates from the Wilfley tables are dressed up in a buddle by hand into "firsts" and "seconds" and "tails," which are returned to the mill circuit. Although a fairly good concentrate is obtained from the tables, it is not considered advisable, on account of the varying metal contents of the feed, to attempt to make a clean product. The "tails" from the Wilfley tables were for a while passed over a fine jig, but the results did not justify this, and they are now allowed to run away.

The settler provides feed for two Frue vanners, the concentrates from which are dressed up in a tossing tub, or keive, to "firsts" and "seconds," and "tails," which are returned to the mill circuit. The "tails" from the vanners and the fine Wilfley were passed over canvas tables, but the concentrate obtained barely paid for the renewal of the canvas; and in this case the canvas tables or strakes were not a success. This was mainly owing to the large amount of magnetite contained in the pulp, and to the fact that they did not present any better methods of saving than

the machines, the tailings from which they treated. The product from the canvas tables was a very foul one, although the tables were well looked after; and considerable dressing by hand was required to bring it up to anything like a decent standard. In such cases, if the losses, not being due to faulty working of the vanners, justify it, the remedy appears to be to instal further machines of different adjustment. The wear on the feed and "tail" launders is, owing to the sharp nature of the ore, very considerable. For protection, $\frac{1}{4}$-in. steel plates were used. During the recent high cost of steel plates, strips of hard cast-iron, 8 in. wide x $\frac{1}{2}$ in. thick x 3 ft. long, were tried, and these wore so satisfactorily that they have been adopted for general use.

All the concentrates produced are drained and dried. The drier is constructed of two $\frac{1}{4}$-in. plates, 6 ft. long x 3 ft. wide, with angle-iron sides, laid in tandem on brick walls. A small furnace at one end, so arranged that the flame does not come in contact with the plates, provides the heating. After drying, the concentrates are bagged in 1 cwt. bags and despatched to a magnetic separation works located at Launceston and owned by the Syndicate. A description of that plant and of its working is appended.

The mill is driven by water-power under a head of 375 ft. For the rock-breaker, the speed of which is very variable, a 36-in. diam. Pelton wheel is provided. A 60-in. diam. Pelton wheel drives the rolls, trommels, elevator, and coarse jigs, the speed of which to a certain extent is variable according to the work on the rolls. A $\frac{3}{4}$-in. nozzle is used for this wheel. For the fine jigs, Wilfleys, and vanners, the speed of which requires to be constant, a 36-in. Pelton wheel, under a $\frac{1}{2}$-in. nozzle, provides the power. In this latter case, in the winter months and cold weather, it is found that the required speed is not attained with a $\frac{1}{2}$-in. nozzle until the various bearings warm up. It is then the practice to use a $\frac{9}{16}$-in. nozzle, and, as the speed increases, to regulate it with a deflecting shield operated by a hand wheel and screw.

Power.

Water-power for compressor, pumps, concentrating mill, and saw-bench is obtained from a race $5\frac{3}{4}$ miles in length. The grade of the race is 16 ft. to the mile, and the width at bottom is 20 in. The race passes through forest country and frequently along precipitous sidings. The fall of 16 ft. to the mile is necessary to prevent accumulations of leaves and debris; and the basaltic soil in which the race is excavated does not cut, but rather tends to wear rounded with this fall. The main pipe line is some 1700 ft. in length, and ranges in diameter from 20 in. at the intake down to 11 in. at the mill. Branches convey the water to the pumping plant and to the compressor drive. In all cases Pelton wheels are used under heads of 350 ft. at the compressor and pumps and 375 ft. at the mill.

For air-compression a two-stage enclosed type belt-driven machine, of 400 cub. ft. free-air capacity, is driven by a 44-in. Pelton wheel. The nozzle diameter is $1\frac{9}{16}$-in., and a 12-in. link leather belt is used as a drive from Pelton wheel to compressor.

The water supply can be relied upon for about 9 to 10 months of the year. Storage is not obtainable within 6 or 7 miles of the mine, and beyond this only to a limited extent. To obtain a supply of water for the whole year would involve a heavy capital expenditure, and there would still be doubts as to its permanency. As a stand-by an auxiliary steam plant has been installed. This consists of two Robey loco-type boilers, each of 500 sq. ft. heating surface, with fire-boxes adapted for 5-ft. wood. The steam pressure is 135 lb. per sq. in. A vertical high-speed 2-stage air and compound-steam compressor, of capacity of 400 cub. ft. of free air, is used under steam. When water-power is available and compressed air is cheap, hoisting is done by an air winch located at No. 3 adit. As an alternative, a steam winch located at the surface is used for hoisting ore and water. With good wood (myrtle and sassafras cut green and allowed to dry), one boiler is able to steam for compressor

and hoist on a consumption of about 220 cub. ft. of wood per 8-hour shift. This includes the wood necessary for raising steam.

The feed water is fed direct from the water main, which at the boiler house has a pressure of 150 lb. per sq. in.; but when necessary it is fed from a feed pump. The steam hoist is located at the main shaft, distant 330 ft. from, and at an elevation of 90 ft. above, the boilers. The steam is conveyed by a pipe line suitably lagged, and expansion is provided for by expansion joints and long sweeping bends. Condensation is taken care of by a water trap fitted with a Geipel separator. No trouble is experienced with water in the winch cylinders, although the work is intermittent.

Engine wood in 5-ft. lengths is brought in from the bush by a short tram line of 36-in. gauge; 4 in. x 3 in. wooden rails are used. The steepest grade is 1 in 7, and on this, in wet weather, the rails require to be sanded to prevent the truck wheels skidding. The loaded truck is run down by gravitation and is hauled back by a horse. From the end of the tram the wood is sent down to the boiler house along a wooden chute, the grade of which is 1 in 5 and the length 75 ft. This grade appears to be the limit necessary to carry rough wood.

Whilst the auxiliary steam plant is almost a necessity as a stand-by in cases of break-aways and stoppages of the race, it also happens that the cost of the fuel and extra labour does not amount to as much as the interest on the difference between the cost of the steam plant and that of the (alternative) water-power extension. At the time the steam plant was installed, suction gas was considered but turned down owing to the difficulty of obtaining charcoal or coke. With the advent of wood-burning producers the position has been altered, and it is probable that any extension will include a suction-gas plant. The mill is dependent upon water for power, and some little difficulty exists in that when power water is short dressing water is scarce also, and any scheme to enable the mill to run continuously requires also to provide for a supply of dressing water. This is not an

easy matter, especially as the requirements for a concentration mill are large. The practice now adopted is to store ore in a large dump of 1000 tons capacity and to allow stocks of broken ore to accumulate in the stopes. When water is available these stocks are dealt with by running extra shifts at the mill, which, as a rule, only runs on day shift.

For cutting timber for mine and building use there is used a saw bench, operated by water power. The saw is directly driven by an 18-in. Pelton wheel on the saw spindle. The head of water is 375 ft., and a $\frac{9}{16}$-in. nozzle, which can be raised or lowered for stopping and starting by a lever handy to the bench, serves for this work. The practice, in cutting timber, is to "spot" opposite sides of the log, and, after running a cut along the middle from one side, the log is turned over and a second cut from the other side is made to meet the first. In this way logs up to 42 in. diam. can be handled.

For the forges, blasts are provided by a compressed-air jet and also by a small fan driven by a Pelton wheel supplied by water from an adjacent creek.

Since milling was started by the present owners, in 1907, the quantity milled to 31st December, 1918, has been 72,884 tons of 22 cub. ft. The production of concentrates from this has been as follows :—

	tons.
Firsts, containing Sn, Wo_3, and Bi	822.00
Seconds, containing Sn, Wo_3, Bi, and Pyrite ..	354.55
Slimes, containing Sn, Wo_3, and Bi	66.95
Bismuth Ore, hand-picked	26.80
Wolfram, hand-picked	3.25
Tin Ore	.05
Total Concentrates	1273.60

The development footage during this period, including sinking, driving, and rising (except for stopes), totals 11,877½ ft. This serves to show the great amount of opening-up work necessary on small lodes such as are worked at this mine.

The Magnetic Separation of Ores.

The Practice at the Works of the S. and M. Syndicate Ltd., Launceston, Tasmania.

Magnetic separators are machines for separating minerals differing in magnetic properties, and there are many types of these machines in use.* At the Launceston works of the S. and M. Syndicate Ltd., Wetherill magnetic separators are installed, with accessory appliances for crushing and sieving the ore to be treated. Such ore is usually a concentrate from a previous wet-dressing process. This concentrate is a mixture of heavy minerals not further separable by the ordinary wet-mill operations on account of their similar specific gravities. The concentrates are here crushed, as necessary, in rolls, and sieved when dry through a set of shaking screens until the whole is divided into four sizes, ranging from one-eighth of an inch in diameter downwards. Each size is then treated on a magnetic separator.

DESCRIPTION OF WETHERILL SEPARATORS.

The essential feature of the Wetherill magnetic separator lies in the passage of the ore on a conveyor belt through the magnetic field between a flat pole and a V-shaped pole of opposite polarity. In such a magnetic field the magnetic particles are attracted towards the V pole from all positions except those in the immediate neighbourhood of the flat pole. The machines at Launceston have two sets of magnets. Each set consists of two electro-magnets—the one with two V poles above the conveyor belt and the other with two flat poles which are below the belt and opposite to the V poles. Each pair of electro-magnets is connected in series, and by regulating the strength of the electric current we can adjust the lifting power of the set. The first pair of electro-magnets is used to pick up the strongly magnetic minerals, such as magnetite, and the second pair is used to pick up the feebly magnetic minerals, such as wolfram ; in other words,

* See C. G. Gunther, "Electro-Magnetic Ore Separation" (1909); R. H. Richards, "Ore Dressing," vols. ii. and iii. (1903-9).

the first pair form a weak and the last pair a strong magnetic field. The dry ore is fed uniformly on to the conveyor belt, which passes on top of the four flat poles and beneath the four V poles. The minerals attracted to a V pole are removed by an endless cross-belt moving just beneath it and at right angles to the conveyor belt. As these magnetic particles pass out of the magnetic field they fall into a chute and a bin at the side of the machine. On these machines there can thus be collected from the four V poles four magnetic products, but generally those from the first two V poles form one product and those from the last two form the second product. These machines take an electric current of about 20 amp. at 110 volts, each machine being provided with a d.c. dynamo and with appliances for regulating the current. The two dynamos and the whole plant are driven by a 14 h.p. motor supplied with three-phase alternating current by the Launceston Corporation.

CONDITIONS OF WORKING WETHERILL SEPARATORS.

The conditions necessary for the satisfactory working of these Wetherill separators may now be summarized; these conditions also hold in general for other magnetic separators. The first essential for good working lies in the close sizing of the ore fed to the machine. The magnets are brought as close as possible to the ore, so as to obtain the full benefit of the magnetic fields. It is evident that large differences in the sizes of the particles of the ore being treated must lead to uneconomical handling of the finer portion, which could be better treated by itself. An even distribution of the particles over the conveyor belt, which takes them past the magnets, is clearly desirable, and is ensured by means of a suitable feeding device. At the works under review a shaking-bar feeder is favoured, which moves with a set stroke at a given distance beneath a slot in a hopper bottom. Both length and time of stroke of the bar are capable of close regulation as well as the distance from bar to slot, and thus any size and variety of ore may be fed as desired on to the conveyor belt. The speed of the cross-belts (that take the magnetic particles from

beneath the magnets to the side chutes of the machine) needs to be sufficient to carry the particles clear of the magnet, and a speed of about 300 ft. per min. is usually ample.

The speed and width of the conveyor belt are important, as they largely fix the capacity of the machine. The width must not be too great, because the wider the belt the larger the air gap necessary between upper and lower poles, due to the increased space required between the conveyor and the cross-belt to allow the two streams of ore to pass. Consequently, the wider the belt the more electric energy is required to remove the same amount of any given mineral. Here, again, the magnet construction will be more difficult, for, apart from the above considerations, the amount of magnetism (*i.e.*, the total number of magnetic lines of force generated) must be at least proportional to the width of the belt, and this must be produced by longer or thicker coils or by greater current-strength. There is a practical limit to each of these factors, and the maximum width of conveyor belt made on Wetherill separators used for feebly-magnetic minerals is 18 in. In the syndicate's machines the magnet poles are 14 in. wide, the conveyor belt being a little wider. The speed of the conveyor belt cannot be increased beyond a certain point if the *quality* of the separation is to be maintained, as a magnetic mineral must remain a definite time beneath a pole in order to be attracted to it—the larger the mineral particle the longer the time. For this reason fine ore may be treated with a faster conveyor-belt speed than coarse ore, assuming the ore is one layer deep in each case. However, the actual rate of treatment (weight of ore machined per day) does not increase indefinitely as the ore-size diminishes. The best size of material to treat with this type of machine is, generally speaking, that "minus 10 and plus 20 mesh," averaging 0.04 in. in diameter. A device to vary the speed of the conveyor belt is an advantage, as then re-treatment of the supposed non-magnetic tailings from the machine may always be avoided. The greater the amount of magnetic material in an ore, the slower it must be fed beneath the magnets, otherwise the percentage of magnetic material in the

tailings will increase proportionately. Such a slower feed can best be obtained by thinning out the ore on the belt *and* by decreasing the speed of the belt. The conveyor belt speed should be capable of variation (by steps) from about 50 ft. to about 100 ft. per minute.

THE CAPACITY OF WETHERILL SEPARATORS.

The capacity, or rate of treatment of ore, of a Wetherill magnetic separator depends on—

(1) The width of the magnet poles, and thus of the conveyor belt.

(2) The speed of the conveyor belt.

(3) The thickness on the belt of the layer of ore particles, and the size of the latter.

(4) The strengths of the magnets (and their number).

(5) The nature of the separation desired.

It has been shown above that increase in each of the first four factors favours increased capacity, but that these factors cannot be raised above a certain limit. In practice there is effected a compromise between the development of each of these factors, a compromise largely decided by the fifth factor, which is, of course, the most important feature of any given machine.

In the case of mixtures of bismuth or tin minerals with wolfram, the treatment of which represents the greater part of the Launceston work, it is desired to obtain *complete* separation of the valuable minerals from one another, quite apart from the fact that penalties may be imposed on the seller of mixtures of these minerals. The Syndicate is here working under the severest conditions, and that at once precludes any record-breaking capacities. For example, users of Wetherill machines which are separating ferruginous zinc-blende (ZnFe)S, from galena, PbS, are satisfied with zinc and lead products that contain appreciable impurities—*e.g.*, a lead product assaying 50 % Pb and 5 % Zn—and thus it pays them to push "capacity" at the expense of com-

pleteness of separation. It is found that figures quoted from American practice on such ores regarding the capacity of Wetherill separators, are far in excess of that which obtains at Launceston in wolfram separating. In the present case the *quality* of the separation comes first, the aim being to maintain the highest grade of products possible with any given ore, and it will be sufficient to indicate that on an average cassiterite–wolfram concentrate the rate of treatment of one machine is about three-quarters of a ton in 24 hours.

These Wetherill separators are simple to work, easy to regulate and to clean, and the magnetic fields can be finely adjusted. The ore must be perfectly dry and of appropriate size (*v.s.*). These machines are not suitable for "slimes"—that is, say, material passing through a 150-mesh sieve—for such material sticks to the conveyor and cross-belts and is carried round with them past the proper bins. Also, in falling into the various chutes and bins the slime creates dust. For slimy ores a magnetic separator that will treat the wet material is required.

THE S. AND M. MINE ORE AND CONCENTRATES IN GENERAL.

There will now be considered in detail the results obtained with these Wetherill separators on the concentrates from the S. and M. mine, Moina, Tasmania. The run of mine ore is there treated in a typical wet mill, from which two main grades of concentrates are forwarded to Launceston. These are known as "firsts" and "seconds" concentrates, the former being the better product.

The S. and M. "firsts" concentrates contain mainly bismuthinite, cassiterite, and wolfram, which are the minerals of economic importance, and together make up about 98 % by weight of the concentrate. The remaining 2 % by weight consists of pyrite, magnetite, scheelite, and silica. The S. and M. "seconds" concentrates contain all the above minerals in quantity, together with small amounts of chalcopyrite, molybdenite, siderite, and other minerals. In connection with the following data approximate average results alone can be given, as the concentrates are

continually changing in details, though their general characters remain the same. For instance, in the S. and M. "seconds" the amounts of pyrite and magnetite vary considerably, and in both "firsts" and "seconds" the ratios bismuthinite : wolfram : cassiterite are constantly altering.

TREATMENT OF THE S. AND M. "FIRSTS" CONCENTRATES.

The S. and M. "firsts" concentrates, on treatment with the magnetic separators, give a little magnetite product from the first two V poles, those of the weak electro-magnet, then a wolfram product from the last two V poles, those of the strong electro-magnet, and finally a non-magnetic product of cassiterite and bismuthinite, with small amounts of scheelite, silica, and pyrite. The magnetite product contains a little magnetic pyrites and merely traces of the valuable metals. The wolfram product averages about 73 % WO_3, with 0.7 % Sn and the merest trace of Bi, while the tin-bismuth product assays in general about 63 % Sn and 4 % Bi, with 2 % WO_3 or more, depending on the amount of scheelite present. These last two products are sold—the wolfram at present to the British Government, and the tin-bismuth ore to an English chemical works, where the bismuth is extracted, and then the remaining tin ore is taken by a tin-smelter. At present the magnetic separation process gives the following results from the "firsts" (the relative amounts of the various products changing from time to time as above mentioned) :—

Results Obtained from S. and M. "Firsts."

Product.	% Wt.	Assays.			Recoveries.		
		% WO_3	% Sn.	% Bi.	% WO_3	% Sn.	% Bi.
Iron minerals ..	0.5	—	—	—	—	—	—
Wolfram ..	42.5	73	0.7	—	96.9	0.8	—
Tin-Bismuth ..	57.0	2	63.0	4	3.1	99.2	100
Original "firsts"	100.0	36.5	36.2	2.3	100.0	100.0	100

Scheelite is an undesirable mineral in these concentrates, as it means the presence of tungstic acid (WO_3) in a non-magnetic form, which therefore cannot be separated from the tin–bismuth ore by magnetic separators. The wolfram content of the final tin–bismuth product does not exceed 1 % of its weight, and of this a considerable part is associated with the cassiterite. A single particle, consisting of wolfram and cassiterite together, will pass into the wolfram or tin–bismuth product, according as the one or the other mineral is in excess ; in either case the quality of the separation suffers. The relative amount of such undesirable particles will vary with each ore treated, as some ores, on crushing, separate into their constiuents more readily than others. This problem of "associated particles" is common to all mechanical methods of separation, and the balance must be found between their re-crushing and re-treatment and the cost of these extra operations and the further separation thus possible. It happens that the S. and M. ore is of a more complex character than is shown by other ores, from which, therefore, a more complete separation into purer products can be obtained (see later).

TREATMENT OF THE S. AND M. "SECONDS" CONCENTRATES IN GENERAL.

The S. and M. "seconds" concentrates, on treatment by the magnetic separators, give three products. The first product consists of magnetite and magnetic pyrite, the former mineral predominating. The major portion of the product comes off from the first V pole, and is almost wholly magnetite, while from the second V pole comes the minor portion, which contains the bulk of the magnetic pyrite. The "magnetite" occurring in the S. and M. concentrates contains some rock minerals intimately associated with it (see Twelvetrees, *loc. cit.*), but it is still quite strongly magnetic. This "iron-product" contains very small amounts of the valuable metals, and is removed as waste. The second product from the machining of the "seconds" contains wolfram with considerable magnetic pyrite and smaller amounts

of siderite and garnet or vesuvianite.* The third, or non-magnetic product, contains bismuthinite, cassiterite, pyrite, scheelite, silica, etc.—that is, all the non-magnetic minerals present in the original "seconds." This product may contain over 50 % by weight of pyrite.

MAGNETIC AND NON-MAGNETIC PYRITE FROM THE S. AND M. ORE.

The pyrite in the S. and M. "seconds" thus varies in magnetic quality, though the bulk of it is non-magnetic. Pure, hand-picked specimens of the pyrite from the above three products were assayed, with the following results :—

Pyrite Sample.

	I. Strongly Magnetic.	II. Weakly Magnetic.	III. Non-Magnetic.
% Fe	45.1	45.3	45.5
% S	47.4	47.3	50.3
% Cu	0.0	0.0	2.1
% insoluble	3.8	3.0	0.7
% soluble (by difference)	3.7	4.4	1.4
Ratio, $\frac{S}{Fe}$	1.052	1.045	1.105

The quantities available for assay were small, but the results, considered only relatively, are instructive. Sample III. contained appreciable copper, the figure for which includes a little bismuth. The sulphur contents are most likely to have been under-

* A light grey to brown mineral which may be either garnet or vesuvianite has long been present in this wolfram product. It is very similar to wolfram in magnetic quality. It gives a whitish streak and powder, and has hardness = 6·5, specific gravity = 3·57, and fusibility = 3. A section of a grain prepared for microscopical examination was colourless, isotropic and possessed marked relief, characters constituent with its being either garnet or vesuvianite; the writer's thanks are due to Mr. W. H. Twelvetrees, Tas. Govt. Geologist, for the microscopical examination and the determination of this mineral.

estimated. The notable feature is that the magnetic varieties of the pyrite contain the most impurities. The impurities insoluble in acids (aqua regia) are cassiterite and silica (or rock minerals). The ratios S : Fe indicate possibilities of magnetite being an impurity in samples I. and II., even to the extent of about 4 % by weight; the S : Fe ratio for FeS_2 is 1.147. Such a quantity of magnetite would probably carry some particles into the "iron-product," while less than this would suffice to carry some pyrite into the "wolfram product." It must be remembered that these assay samples of the various sorts of pyrite were specially chosen, being well-crystallized pieces, mostly cubes or broken cubes, averaging about 0.1 in. in diameter. However, in samples I. and II. minute dark specks of impurities can be seen by the eye in some of the otherwise perfect though small cubes present.

THE ROASTING OF PYRITE FOR MAGNETISM: THE S. AND M. ROASTING PRACTICE.

The pyritic wolfram and the pyritic tin-bismuth products from the machining of the "seconds" are both of too low a grade to send direct to market. Advantage is now taken of the fact that iron pyrites (FeS_2) may be converted into strongly magnetic sulphide and oxide of iron—approximately Fe_3S_4 and Fe_3O_4—by means of a partial roast. The above two products are thus separately roasted, cooled, and then again treated on the Wetherill machines, when the strongly magnetic roasted iron pyrite is removed by the first weak electro-magnet, leaving the wolfram or the tin-bismuth ore to be recovered later from the machine as a high-grade product.

The roasting of pyrite "for magnetism" is a fairly common operation being adopted on a large scale in the United States of America, chiefly in connection with the separation of pyrite from zinc-blende and galena, such mixtures being the middlings produced in the wet dressing of pyritic zinc and lead ores (*vide* Gunther and Richards, *loc. cit.*) Pyrite, FeS_2, on heating, decrepitates at 60° C., and commences to rapidly lose sulphur

from 400° C. In the presence of air it thus ignites at the latter temperature, and it becomes incandescent at about 500° C. Pyrrhotite, with a composition usually about $Fe_7 S_8$, ignites at about 500° C. in air. The decomposition of pyrite on roasting may be represented as follows :—

$$FeS_2 = Fe_7 S_8 + S \text{ (burning to } SO_2\text{), from 400° C.}$$
$$= Fe_3O_4 + SO_2, \quad ,, \quad 500° \text{ C.}$$
$$= Fe_2O_3, \quad ,, \quad 500° \text{ C.}$$

The final oxide of iron obtained will depend on the conditions. Free access of air and temperatures from 500° to 1100° C. approximately favour formation of ferric oxide, while a limited air-supply, the presence of reducing gases (CO, H, SO_2), and extremely high temperatures lead to the tetroxide. The following table gives approximately the ignition temperatures in air of those sulphides that have a bearing on the roasting practice ; the figures are taken from Friedrich's researches, as recorded, with references, in Hofman's "General Metallurgy" (1913). The ignition temperature of a sulphide, however, varies with the conditions of the test, and especially with the size of the sulphide particles tested. The following figures refer to very fine ore, 0.006 in. in diameter, approximately.

Ignition Temperatures in Air of Various Sulphides.

Pyrite, FeS_2	400° C.
Pyrrhotite, $Fe_7 S_8$	500° C.
Ferrous Sulphide, FeS	500° C.
Molybdenite, MoS_2	500° C.
Chalcocite, Cu_2S	550° C.
Bismuthinite Bi_2S_3, ...	600° C.

In roasting pyrite for magnetism the aim is to get a product of uniform magnetic quality, which will consist of magnetic sulphide and oxide of iron. The larger particles, after roasting, will contain a kernel of unaltered pyrite, then a layer of magnetic sulphide, and on the outside a coating of magnetic oxide. The finer particles of roasted ore will be practically wholly magnetic oxide.

Coarse ore takes a longer time to roast to a required magnetic quality than fine ore, and the ore should therefore be carefully sized before roasting. It should all pass through a 10-mesh sieve —*i.e.*, the particles should be less than 0.05 in. in diameter. Material of half this size, and less, behaves better as regards the roasting, but then the extra crushing and the behaviour on the magnetic separators would become serious items. It is the Launceston practice to crush the "seconds" concentrates into three sizes, from 0.05 in. diam. downwards, each size being subsequently treated by itself.

At the works in Launceston the closely-sized products are roasted in a small muffle furnace, and are rabbled by hand. Air is admitted in limited quantity through the door of the muffle and the gaseous products of the roasting—sulphur and sulphur dioxide—pass out at the farther end of the muffle and into the chimney. The cast-iron muffle is heated by a wood fire placed at one side, and the flame passes right round it and then up the chimney, the draught of which also causes the air-current through the muffle. The ore charge is about 2 in. deep, and is rabbled from 4 to 6 times an hour. The average time of roasting a charge, approximately $1\frac{1}{8}$ cwt., is $1\frac{1}{2}$ hours, or the mean rate of roasting, all S. and M. pyritic products being considered, is $\frac{3}{4}$ cwt. per hour. This is neglecting the time taken to heat up the furnace on Monday morning in each week, which is about 6 hours. The furnace thus treats $5\frac{1}{8}$ tons of ore per week of six days, with a fuel consumption of $8\frac{3}{4}$ tons (1 ton = 80 cub. ft.) of firewood. This type of furnace is only suitable for small tonnages, such as are dealt with, and is thus expensive compared with larger installations with mechanical feeding and rabbling. The cost of roasting runs out at about £2 15s. per ton of ore roasted, this being largely dependent on the life of the muffle. A good muffle ought to last out the roasting of 100 tons of pyritic ore. The great advantage of this type of furnace is that the dust losses are reduced to a minimum. The results obtained are satisfactory, as the "end-point" of a roast can be judged with accuracy, and small variations in the temperature, rabbling, time of

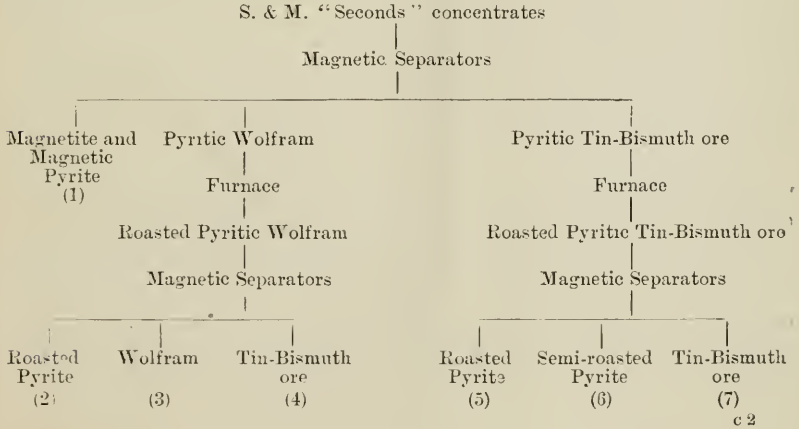
roasting, and quantity and quality of the ore roasted can thus be arranged so as to compensate each other. When finishing off the roasting of a charge of ore the muffle is at a good red heat, say at 650° C. If the temperature is lower the roasting takes too long; if higher the various ore-particles frit together excessively, and the subsequent magnetic separation is adversely affected.

When the roasting is approaching completion, the charge of ore should throw off very few sparks on rabbling. During the early stages of the roast this sparking of the charge is pronounced; it is due to the decrepitation of the pyrite and the incandescence of the rapidly burning particles that are thrown up from the surface of the charge. Also, at the end of the roast the ore will appear uniformly red hot, and will give a short flame on rabbling—not a long flame as when half done. The (cooled) roasted ore should be dull grey-black in colour, and no shiny particles of unaltered pyrite should be visible. Only the surface of the cooled roasted charge should show a reddish-brown tint (due to further oxidation to ferric oxide); if there is a red-brown tint throughout, the charge is over-roasted. Ferric oxide is feebly paramagnetic, and the aim is to form the strongly paramagnetic compounds of iron. However, in practice over-roasting rarely occurs. If the ore is under-roasted, then bluish-black particles will be seen. These bluish particles contain large kernels of unaltered pyrite, and are thus only weakly magnetic. The roasted ore-particles should be very slightly sintered together. Any marked sintering or fritting together of the ore is due to the temperature (or time) of roasting being too great. Any sign of fusion of the bismuthinite points to the same bad conditions, which, however, with ordinary care are easily avoided. A sample of the ore may always be removed from the furnace, rapidly cooled, and examined. Under-roasting is the main thing to guard against, especially if the ore is coarse and very rich in pyrite. It is generally safer to give the ore a quarter of an hour longer in the furnace if there is any doubt. In practice any given lot of uniformly sized ore will have a constant time of roasting under normal conditions.

The roasted ore contains coarser as well as finer material than that started with. Pyrite decrepitates on heating, and thus we get a certain amount of fines made ; the cassiterite and quartz may also decrepitate to a certain extent. Again, in changing to the magnetic sulphide and oxide pyrite increases in volume, and thus ore coarser than that started with, is found in the roasted product. This coarser portion is small in amount and is almost wholly magnetic iron-mineral. The pyritic tin–bismuth ore is the main product to be roasted, and it contains about 60 % by weight of pyrite. This product loses about 11.5 % of its weight in the roasting. In the change from FeS_2 to $Fe_7\ S_8$ the loss of weight is 23 % of the original weight, while formation of oxides of iron involves further loss of weight. Thus an ore with 60 % of pyrite should lose 14 % of its weight if the above chemical change is completed. This reaction is, in practice, thus incomplete, and indeed it has already been mentioned that the coarser particles of the roasted pyrite contain kernels of the unaltered sulphide, FeS_2.

TREATMENT OF THE S. AND M. "SECONDS" CONCENTRATES (*continued*).

The whole treatment of the S. and M. "seconds" concentrates may now be summarized by giving the flow sheet of the operations involved.



The final products are numbered 1 to 7, and will be discussed in order.

Product 1 has already been considered (see p. 61).

Products 2 and 5 consist of the strongly magnetic roasted pyrite, which carries some of the valuable minerals. This is the weak part of the process, as it is impossible to avoid a little sintering together of the ore-particles during the roasting. Moreover, the bismuthinite in the ore is closely associated with the pyrite, and the original "seconds" contain such composite particles in appreciable quantity, and these carry their bismuth into the "iron-products," 2 and 5. This also explains how the "pyritic wolfram" from the "seconds" gives rise to bismuth-bearing, roasted pyrite (2), and a very little tin–bismuth ore (4). These metals are brought into the "pyritic wolfram" from their association with the magnetic pyrite there present. It is found, without exception, that in the various S. and M. wolfram products the impurities, tin and bismuth minerals, are proportional to the pyrite content. Chalcopyrite ($CuFeS_2$) and cupriferous pyrites, which are also present in the "seconds," form magnetic ore on roasting just as pyrite does, and thus copper is carried into the products 2 and 5. These products are sold together as a low-grade bismuth ore containing from 6 % to 9 % Bi.

Product 3 is a marketable wolfram ore, though the tin and bismuth contents are high for this class of material. It averages 60 % WO_3, corresponding to 80 % of wolfram, the remainder being incompletely roasted pyrite, siderite, vesuvianite, and associated quartz, cassiterite, and bismuthinite.

Product 6 consists of pyrite that is incompletely roasted and of composite particles of roasted pyrite with other minerals. Both of these constituents are necessarily only feebly magnetic; any wolfram left in the pyritic tin–bismuth product (before roasting) will also separate here. In general, the amount of this product compared with the amount of the well-roasted (*i.e.*, highly magnetic) pyrite (5), gives the best test of the efficiency of the

roast for magnetism of the pyritic tin–bismuth product. From a perfectly-roasted ore this product (6) would be of negligible amount. This product contains WO_3, Sn, and Bi in large amounts, and is marketed as a "mixed ore."

Product 7 contains the bulk of the cassiterite of the original "seconds" together with some bismuthinite, appreciable silica and scheelite, and small amounts of pyrite, molybdenite, etc. Product 4 is similar, but is formed in very small amounts. This tin–bismuth ore (4) + (7), may be reconcentrated in a small wet-dressing plant, where the grade of the tin–bismuth ore will be raised by the elimination of some of the silica. The high % WO_3 in this product (7) is due to the scheelite present in the original "seconds" accumulating at this point.

The accompanying table gives a typical result obtained by the foregoing processes on a parcel of "seconds" concentrates that had the composition below:—

Analysis of "Seconds" Concentrates.

Bismuthinite	= 4.2 %,	equivalent to	3.4 % Bi.
Cassiterite	= 14.9 %,	,,	11.8 % Sn.
Wolfram (and Scheelite)	= 13.0 %,	,,	9.7 % WO_3.
CuS (as Chalcopyrite, &c.)	= 1.0 %,	,,	0.66 % Cu.
Silica, etc., insol. in acids	= 8.2 %		
Pyrite	= 44.7 %		
Magnetite	= 10.5 %		
Other soluble matter	= 3.5 %		
	100.0		

In the above analysis some of the rarer constituents, as molybdenite, siderite, vesuvianite, are included in the "insoluble in acids" and the "other soluble matter" figures, while the division in amount between "pyrite" and "magnetite" is somewhat rough. The analysis will, however, indicate the complex nature of the ore treated.

Table of the Results Obtained from the S. and M. "Seconds."

Products.	Wt.	Assays						Distribution					
		Bi.	Sn.	WO_3.	Cu.	SiO_2.	Sol.	Bi.	Sn.	WO_3.	Cu.	SiO_2.	Sol.
(1) Magnetite and Magnetic Pyrite ..	15·0	0·5	1·5	0·6	0	9·5	87·1	2	2	1	0	18	23
(2) Roasted Pyrite	3·1	4·9	2·8	10·6	0·5								
(3) Wolfram	11·2	1·0	3·2	59·2	0	8·6	6·8	3	3	70	0	12	1
(4) Tin-Bismuth ore	0·1	1·7	51·5	6·3	0								
(5) Roasted Pyrite	35·2	6·4	3·5	0·9	1·2								
(6) Semi-roasted Pyrite	6·5	6·1	22·0	14·3	2·0	13·9	28·6	12	12	9	20	11	3
(7) Tin-Bismuth ore	17·5	2·3	47·4	7·1	0·5								
Slimes	1·2	3	12	9	0·7	8	59	1	1	1	1	1	1
Loss	10·2	0	0	0	0	0	100	0	0	0	0	0	17
Total	100	3·4	11·8	9·7	0·66	8·2	58·7	100	100	100	100	100	100
(2) + (5) = Total Roasted Pyrite .	38·3	6·3	3·4	1·7	1·1	3·0	81·1	70	11	7	65	14	53
(4) + (7) = Total Tin-Bismuth Ore	17·6	2·3	47·4	7·1	0·5	20·6	7·0	12	71	12	14	44	2

Under the heading "SiO_2" is included all matter insoluble in acids (aqua regia), excepting the SnO_2 and WO_3. Under the heading "Sol." is included all matter soluble in acids, excepting the Bi_2S_3, the (Fe Mn) O and Ca O from the wolfram and scheelite, and the Cu S corresponding to the Cu.

The composition of the slimes has been assumed to be the same as that of the original ore, which experience indicates is very near the truth. (The slimes are gathered up from beneath the magnetic separators; this material is very fine and not further separable.) The loss has been assumed to be all soluble matter. The bulk of the loss is due to the roasting (*r.s.*), where S is lost from FeS_2, oxidation being neglected.

From the table it will be seen that a resolution of the "seconds" concentrates into marketable products has been effected, but considerable losses of the valuable metals occur through the sintering that takes place in the roasting. For example, the roasted pyrite is sold only as a bismuth ore, and thus 11 % of the tin and 7 % of the tungstic acid of the original "seconds" are lost.

THE SEPARATION OF OTHER ORES AT THE S. AND M. WORKS.

Besides the magnetic separation of its own ores, the S. and M. Syndicate also undertakes similar work on ores belonging to other companies. These ores—or rather concentrates—fall into two main classes :—

(1) Concentrates containing wolfram together with tin and bismuth minerals.

(2) Concentrates containing cassiterite with valueless magnetic minerals, such as titaniferous iron ore, chromite, and magnetite.

With the first class of material the completeness of the magnetic separation is largely dependent on the number of "associated" particles present. For instance, concentrates from the All Nations mine, Moina, Tasmania, give a very clean wolfram product, assaying often over 74 % WO_3, with the merest trace of Bi, the non-magnetic product consisting of bismutite, bismuthinite, and a little native bismuth, together with pyrite, silica, etc. Another example of an ideal mixture for magnetic separation is the ore from the Iris mine, Moina ; the wolfram product from this ore averages 73 % WO_3, with very little tin (0.1 %), while the tin product assays 73 % Sn, 0.1 % WO_3. In other cases, owing to the presence in the ores of magnetic minerals such as siderite or monazite, the grade of the wolfram product is lowered. This is not as bad as when tin or bismuth minerals pass into the wolfram product, due to their association with magnetic minerals, such as the wolfram itself, magnetic pyrites, or oxides of iron (hematite, limonite). The S. and M. concentrates suffer in this way to

some extent (*v.s.*). Certain bismuth–wolfram concentrates from New South Wales and Queensland contain wolfram much coated with bismutite, and their separation is thus imperfect. Indeed, the actual behaviour of an ore on treatment by the magnetic separation process can only be exactly determined after a trial sample has been so treated. The actual testing of a few pounds weight of the material under consideration is a simple matter, and this will give *definite* data concerning the possible magnetic and non-magnetic products, which determine the economical aspect of the business.

In the second class of concentrates treated at the separation works of the S. and M. Syndicate there is only one valuable mineral to be recovered. These low-grade tin concentrates come from the north-eastern districts of Tasmania, and contain cassiterite along with ilmenite, spinel (pleonaste), chromite, magnetite, monazite, etc. These last minerals have fairly high specific gravities, and are thus not economically removable from the tin ore by wet dressing ; they are, however, magnetic, and are easily removed by the magnetic separators. Thus the cassiterite is obtained along with the other non-magnetic minerals, such as quartz, zircon, and non-magnetic spinel. (Spinel, essentially $MgAl_2O_4$, has a weakly magnetic to a non-magnetic character, according to the amount of iron present in the mineral ; its colour varies similarly, the highly ferruginous variety, pleonaste, being the tin-miners' "black-jack.") The raising of the grade of the tin concentrate by the magnetic separation process obviously depends on the amount of magnetic material removed, and the final grade of the resulting tin product on the amount of the non-magnetic material present. It is quite common to remove as magnetic material from one-half to two-thirds by weight of the original concentrate, thus raising the grade by 100 to 200 %—*e.g.*, from 30 % Sn or 20 % Sn to 60 % Sn. The resulting high-grade tin concentrates are readily accepted by the neighbouring smelting works of the Mount Bischoff Tin Mining Company.

SUMMARY.

These notes may be closed by a brief summary. The S. and M. mine at Moina, Tasmania, has been a consistent producer of tin-ore, wolfram and bismuth-ore for several years past. The mine and district are described, and the methods of mining and of milling are given in full together with an account of the power plant. The concentrates are then sent to Launceston, where they are treated by Wetherill magnetic separators. There is given an account of this magnetic separator and of the conditions necessary for its satisfactory working. The roasting of pyritic ores, as practised at Launceston for the purpose of forming the magnetic compounds of iron, is also discussed; and the final products resulting from the above operations are indicated, thus completing the sketch of the work of the S. and M. Syndicate Ltd.

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Papers and Discussions.

CONTENTS.

PAPERS—

	Page
Underground Sampling (with 3 Figs.). By Walter G. A. Smith - -	75
Froth Flotation at Broken Hill. By C. C. Freeman - - -	89
What is the Matter with Australian Mining? By F. Danvers Power -	111

DISCUSSIONS—

On Froth Flotation at Broken Hill (C. C. Freeman) - - -	105
On What is the Matter with Australian Mining? (F. Danvers Power) -	117

UNDERGROUND SAMPLING.

METHODS AT THE GREAT COBAR MINES, COBAR, N.S.W.

(PERIOD 1909 TO 1919.)

(Read before the Broken Hill Branch.)

By Walter G. A. Smith.

The Great Cobar Company Limited owns 1100 acres of freehold, which include the Great Cobar Copper Mine and smelters, the Cobar Gold Mine, the Cobar-Chesney Copper Mine, and the Great Peak Gold Mines.

Ore Occurrence.

The ore-bodies in the first three mines—namely, Great Cobar Copper Mine, Cobar Gold Mine, and Cobar-Chesney Copper Mine—are, speaking generally, lenticular deposits of evidently more or less complete metasomatic replacements of the country-rock along a line of powerful faulting. These lenses vary from 150 ft. to 400 ft. in length, and from 20 ft. to 100 ft. in width.

[This paper is separately bound, and may be, if so desired, detached complete from this number.]

A short description of the mode of occurrence in each respective mine is here given in order that the rigid method of sampling followed in these mines may be clearly understood.

Mode of Occurrence of Ore-Bodies.

The Great Cobar Copper Mine.—The ore-bodies at the Great Cobar Copper Mine are three separate lenses—the north, the middle, and the south—and consist of replacements occupying shear zones and the intervening space between contiguous zones of shearing. The country-rock is slate of Silurian or older age.

The middle and south lenses were certainly connected at the surface originally, as doubtless were the middle and northern lenses, prior to the erosion of the original outcrop. The western or footwall side is formed by a fault which limits the ore-deposition in that direction. East from the footwall to the hanging wall, if such it can be called, there is first a small quantity of an intimate mixture of galena and zinc-blende, then the primary ore proper, consisting of pyrrhotite mainly, some pyrites, and magnetite carrying chalcopyrite. Following this is an ore, mainly magnetite, but carrying some pyrrhotite and chalcopyrite, and finally siliceous ore consisting of altered slate (silicified and carrying magnetite) traversed by bands of quartz, with chalcopyrite and some pyrrhotite, and finally gradating into magnetite or silicified slate with quartz seams, but very little chalcopyrite.

Cobar Gold Mine.—The lode in this mine is a siliceous ore-body, mainly of replacement quartz, occupying a sheared and faulted zone in rock of similar age to the Great Cobar copper lode, a fold in the bedding of the rock having offered the opportunity for the deposition of the ore. The ore consists principally of quartz, partly replacement quartz, and more or less completely replaced slate, or sandstone, carrying chalcopyrite, and in lesser quantities pyrrhotite, magnetite, pyrite, mispickel, galena, and zinc-blende, as well as appreciable amounts of gold and silver.

The Cobar-Chesney Copper Mine.—The occurrence of the lode at the Cobar-Chesney Copper Mine is similar to that at the Cobar Gold Mine, except that a considerable quantity of the ore

resembles the siliceous ore at the Great Cobar Copper Mine—*i.e.*, it is less of a quartzose and more of a slaty nature, and carries but little gold or silver.

The folding also is not so appreciable in amount as at the Cobar Gold Mine, and, whereas at the Cobar Gold Mine the ore-body is not in the main line of faulting, at the Cobar-Chesney Copper Mine it is so, or nearly so.

The Great Peak Gold Mines.—The ore-bodies at the Great Peak Gold Mines appear to lie along the intersection of shear zones with anticlinal axes, are very erratic, and to some extent apparently secondary. The gold and silver occurs in slate, frequently without the usual accompaniment of quartz, though not invariably so, so that material that frequently resembles worthless country-rock carries payable quantities of gold and silver.

Before entering into the details of sampling operations proper, the author desires his readers to keep in mind the two following important factors relating to (1) the grade of the ore-bodies and (2) the system of stoping in vogue. These two factors have a direct bearing on the method of sampling adopted.

Grade of Ore.

The ore-bodies in the copper mines being low-grade, say $2\frac{1}{2}$ % to 3 % copper, a most rigid and exacting method of close channel-sampling was constantly carried on in order to avoid breaking, or, if breaking was unavoidable, to avoid hoisting unpayable ore. Again, every care was taken to eliminate the chances of foreign matter, such as mullock-filling, getting mixed with the samples whilst sampling was in progress.

System of Stoping.

The "flat-back" system of stoping with filling was worked, and, as the mullock-filling consisted of soft oxidized clay slate quarried in special excavations west of the lode, it will be readily seen that the inclusion of a small quantity of mullock in a sample might change a payable sample into an unpayable one, in a mine where a plus or minus 0.2 % is a consideration.

Sampling Gang and Outfit.

The sampling gang comprised 12 miners, divided into 6 sets of two men per set, one hammer-man and one steel-man, under the personal supervision of the chief sampler and his assistant. The sampling outfit consisted of a 7-lb. double-hand hammer and $\frac{7}{8}$-in. octagon steel cutters with $\frac{1}{2}$-in. chisel points. These cutters are similar to the steel cutters used in narrow lode hand-labour mines for cutting footwall hitches. The bar steel was first cut into lengths of 15 in. to 30 in., the former for face sampling and the latter for back sampling, the moil and pick so often used in other mines being found unsuitable. A sample sheet, 12 ft. by 12 ft., of shot-grained American cloth with a stout duck back, a bannister brush, linen sample bags, sample books, metallic tapes, prismatic compass, field book and chalk completing the outfit.

The sample books employed were of the usual type, each page being perforated and both slip and butt numbered correspondingly. For sampling purposes each level in a mine was given a distinguishing sample letter or letters, the key to which was known only to the general manager, mine manager, and chief sampler, no two mines having the same letter or letters for the same levels; thus, in one mine B might indicate No. 5 level and R No. 12 level, in another mine BB might indicate No. 8 level and RR No. 4 level, the reason for which will be obvious and needs no comment.

This letter or letters, with the number of the sample, is all that appeared on the sample ticket accompanying the sample to the assay office, the particulars of the sample being entered on the sample ticket counterpart.

All development work in progress in ore or lode-formation was kept sampled to within 10 ft. of the face and completed after mining operations were finished.

Sampling Operations.

Sampling a Crosscut.—The backs are rapped out with the hammers, and all baulky ground and "easy stuff"—*i.e.*, loose

ground likely to fall on the sample sheet, is removed ; a datum point is established on some permanently fixed and known point, such as a survey peg in the drive or the centre line of the drive ; a metallic tape held on the datum point is carried to the face at right angles to the strike of the lode, as disclosed, and in close proximity to the backs ; a light, either an acetylene lamp or candle, is placed on the floor vertically under the tape, and the shadow of the tape thrown on the back is traced over with chalk, after which this line is divided into 5-ft. sections ; the sample sheet is laid down ; the miners, removing their boots to eliminate the chances of vitiating the sample, step on to the sample sheet. One man holds the cutter vertically on the back ; the other man strikes it in a manner similar to beating an " upper." Thus a narrow, even channel is cut 5 ft. in length, $1\frac{1}{2}$ in. wide, and $\frac{1}{2}$ in. deep. The sample on the sheet is carefully brushed to the centre, tipped into a sample bag, and, with the sample ticket on top tied in the usual manner. In this case the sample ticket might read :—

22/8/17.
R 41.

whilst the sample book counterpart would show :—

22/8/17.
1206 E. Crosscut Backs.
3rd cut E. to W.
R 41—5 ft.—23 ft. E.
D.P. = S. Peg 92, N. drive.

Note—D.P. = Datum Point.

Sampling a Drive.—The procedure is similar to sampling a crosscut, except that the sample cuts are marked off 5 ft. equidistant across the backs and at right angles to the strike. A full cut across the backs makes one sample, and is measured at right angles to the dip. In sampling a drive-face two cuts are taken across the face—one $\frac{1}{3}$ of the distance down from the back, and one $\frac{2}{3}$ down. These two cuts are mixed and constitute one sample, unless a marked change is noticed in the face, when the changes disclosed are sampled separately.

Sampling Winzes and Rises.—These working places are sampled by cuts taken 10 ft. apart vertically, and staggered alternately on opposite sides at right angles to the strike of the lode, the datum point in this instance being the rail-level above in the case of the winze, and the rail-level below in the case of a rise, the distance either above or below being referred to it accordingly.

Sampling a Stope.—Immediately mullocking operations are completed the sampling of the stope backs is started in advance of the miners, in order to acquire an approximate knowledge of the values likely to be met with prior to breaking. After rapping out and sounding the backs for baulky ground, an examination is made by the chief sampler, and all changes in the ore-body, intrusions, faults, etc., exposed are duly recorded and reported to the mine geologist. A prismatic survey is made from some permanent and known point, such as a rise or permanent country pass, this point being used as the datum point for sampling operations. A diagrammatic sketch of the stope is made in the field book, the strike of the lode established, and a metallic tape held on the datum point is carried to the face parallel to the strike; off-set measurements are taken on this line to all salient

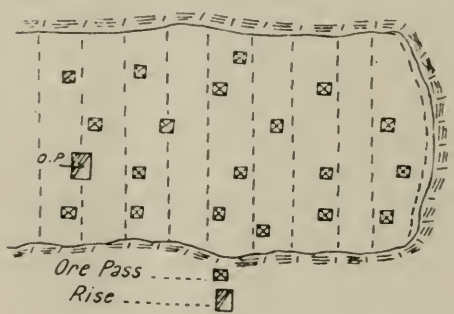

FIG. 1.
STOPE PLAN.—SCALE: 10 FT. = 1 IN.

points, passes, rises, etc., and their bearings and distances picked up from the datum point. Connection is made through the passes to the level below, and the height of backs above rail-level noted. Particulars of this preliminary work are recorded by the chief sampler in his field book.

With an off-setter points are picked up along this line every 10 ft. on the walls of the stope ; a metallic tape is held on these points close to the backs, and the tape line shadowed and chalked off, as was done in the case of a crosscut. The chalk line is then divided into 5-ft. sections across the lode, each 5-ft. section constituting one sample.

Thus the backs of a stope are divided into cuts across the back 10 ft. equidistant along the strike, and subdivided into 5-ft. sample sections across the lode. (See Fig. 1.)

The sample sheet is then laid down and sampling operations started in exactly the same manner as that employed in sampling a crosscut. The stope-face samples are taken by one cut across the face divided into 5-ft. sample sections. Sampling operations in a wide stope, say 40 to 100 ft. wide, would be probably carried on with four or five sets of men, in which case at least 20 ft. would divide each set of men whilst sampling. In this instance the sample ticket might read :—

14/12/17.
B103.

whilst the sample book counterpart would show :—

14/12/17.
508 Stope.
Backs.
3rd cut W. to E. 5th Sec.
B 103—5 ft.—46 ft. N.
D.P. = C.L. 508 Rise H.B. + R.L. = 62 ft.

Note —D.P. = Datum Point ; C.L. = Central Line ; H.B. = Height of Backs ; R.L. = Rail Level.

It occasionally happens that during the cutting of a sample a small quantity of ore or rock will disintegrate from the walls or back and fall on to the sample sheet, mixing with the sample, in which case the whole is rejected and another sample taken. In sampling both stopes and development work running with the lode, it frequently happens that the face is not truly at right angles to the strike of the lode. In such a case the width of the sample is measured at right angles to the lode, and not along the

face. Again, a drive is not always driven parallel with, and a crosscut is not always at right angles to, the strike of the lode, possibly owing to local contortions changing the strike of the ore-body. Instances of these local contortions were encountered in the siliceous ore-body when the mineralized portion of the

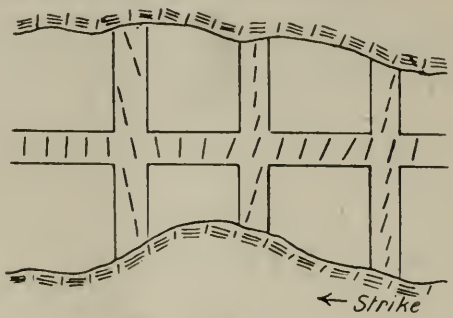

Fig. 2.
Plan.—Scale: 40 ft. = 1 in.

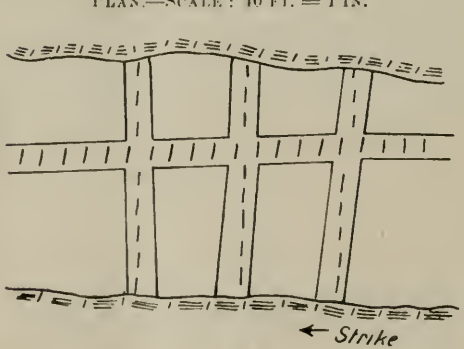

Fig. 3.
Plan.—Scale: 40 ft. = 1 in.

slates—*i.e.*, the lode, was found to be striking in a different direction. In these instances samples were always cut and measured at right angles to the strike of the lode as disclosed at that point. (See Figs. 2 and 3.)

The average weight of sample taken is approximately 2 lb. per foot.

The foregoing description shows the method of underground sampling employed in the Great Cobar Copper Mine, and is

analogous to that followed in the other mines of this company, with modifications in the widths and distances apart as circumstances required. Thus :—

Mine.	Sample width in ft.	Distance Apart.	
		Development.	Stoping.
Great Cobar Copper Mine ..	5 ft.	5 ft.	10 ft.
Cobar-Chesney Copper Mine ..	3 ft.	5 ft.	10 ft.
Cobar Gold Mine	2 ft.	5 ft.	10 ft.
Great Peak Gold Mine	1 ft.	2 ft.	2 ft.

On completion of the actual underground work the samples are sent to the mechanical sample mill, where they are crushed through a Braun pulverizer to pass a 100-mesh, halved by coning and quartering, one-half being discarded, the remainder being thoroughly mixed by careful rolling and again halved by the quartering method and made up into two samples, one being sent to the assay office with the ticket and the duplicate locked in the sample mill safe for referee.

Office Work.

All records of daily sampling operations are entered daily in a Daily Sample Record Book from the sample book counterparts for the information of the mine manager. This book is ruled under following headings :—

Date.....

Great Cobar Copper Mine.

1106 Stope.

D.P. = C.L. 1104 Rise. H.B. = 52 ft. + R.L.

Sample No.	Location.	Width in ft.	Distance from D.P	Cut and Section	Direction.	Remarks.
P 71	Cut across backs.	5 ft.	76 ft. N.	5th-3rd	W-E.	From 70 ft. to 100 ft. N. of D.P. heavy magnetite showing on E. Side.

and is further recorded on the Sample Record Cards.

This is a card system kept specially for sample records, each separate piece of work having a separate card assigned to it. These cards are ruled as follows :—

SAMPLE RECORD.

.....

....Mine.

Date.	Sample No.	Location D.P.	Width Sampled ft.	Assay.					Units.					Reference.
				Cu. %	Au. oz.	Ag. oz.	Fe. %	Insol. %	Cu. ft. %	Au. ft. oz.	Ag. ft. oz.	Fe. ft. %	Insol. ft. %	

On receiving the daily assay sheet the respective assay values of each sample are entered on the cards. It is from these cards that the average widths and average values are calculated for the ore-reserve estimates.

ESTIMATING ORE RESERVES.

In computing values the geometrical mean was used. Where samples are cut equidistant the geometrical mean over the whole area sampled is obtained by multiplying each sample width by its corresponding assay value obtaining in this case, feet % and feet oz., or, in other words, the units contained in each sample. The sum of these units is then divided by the sum of the widths. Expressed as a formula, it is—

$$\frac{\frac{WV}{2} + W_1V_1 + W_2V_2 + \frac{W_3V_3}{2}}{\frac{W}{2} + W_1 + W_2 + \frac{W_3}{2}}$$

when

V = value.

W = width.

It is generally found that the faces in current sampling are at unequal distances apart, and occasionally that in stope-back

sampling samples are unobtainable at equal distances apart owing to baulky ground, etc. Therefore, when computing values where samples are cut at unequal distances apart, allowance was made for the variation of the distance between samples by introducing a distance factor, and the expression becomes—

$$\frac{V\left(\frac{d}{W2}\right) + V_1\left(W_1\frac{d+d_1}{2}\right) + V_2\left(W_2\frac{d_1+d_2}{2}\right)}{\left(\frac{d}{W2}\right) + \left(W_1\frac{d+d_1}{2}\right) + \left(W_2\frac{d_1+d_2}{2}\right)}$$

when

V = value.
W = width.
d = distance between samples.

Or, in the case of development face sample, which amounts to the same thing and is easier to calculate, the average value of two faces multiplied by the distance between them can be taken, and this process repeated for all the faces sampled. The sum of the "distance values" is then divided by the total distance, and the result is the average value of the piece of work sampled.

When estimating ore reserves the ore in situ is divided into two main classes—(1) ore blocked out and (2) probable ore.

It was usually found that three exposed sides of a block was ample justification for the term "ore blocked out." These three sides would probably consist of two levels and a winze through the centre of the block. Then the area of the upper level multiplied by its average assay value, plus the area of the lower level multiplied by its average assay value, modified by any considerations due to the values of the block as proved by the winze, divided by the sum of the areas, equals the average assay value of the block. An example will serve to demonstrate this :—

AVERAGE VALUE OF A BLOCK.

Area of upper level	1800 sq. ft.
,, ,, lower ,, ...	1500 sq. ft.
Average assay value of upper level	2.7 % Cu.
,, ,, ,, ,, lower ,, ...	3.05 % Cu.
,, ,, ,, ,, winze	3 % Cu.

As the average assay value of the winze is higher than the average assay value of the two levels it will not be considered.

Location.	Area sq. ft.	Average Assay Value Cu. %	Units.
Upper level	1800	2.7	4860
Lower ,, ...	1500	3.05	4575

Assay value of block $= \frac{9435}{3300} = 2.859\ \%$ Cu.

The volume is obtained, if the areas approximate closely to one another, by simply multiplying the mean of the two areas by the height between levels; if, however, the areas differ greatly the tonnages are obtained by the prismoidal formula.

$$\frac{H}{3}\left(\text{Area A} + \sqrt{\text{area A} \times \text{area B}} + \text{area B.}\right)$$

Blocks opened on only two sides are usually termed "probable ore." Under this latter category comes also drives on a body of ore which has not been opened at other adjacent levels. In this case 60 ft. (30 ft. above and 30 ft. below the level) is taken as the maximum height of the block.

Ore which may reasonably be assumed to exist below the lowest level is also termed "probable ore," and is (1) either calculated to some arbitrary depth, say 30 ft., or (2) calculated as a pyramid, with the proved shoot area as a base, and a depth equal to one-third of the shoot length.

The ore reserves are estimated annually by the above method for the annual report. Any variations in the calculated widths of one estimate might add to, diminish, or confirm the subsequent estimate. In any case each time they were re-estimated the old balance was written off and the new estimate substituted.

Assay Plans.

These plans were kept by the chief sampler. A plan of the sill floor of each level was taken from the survey plans to a scale of 30 ft. to the inch, and all development work and sill-floor stoping

filled as sampling progressed. Sample cuts, widths, and values were shown in various coloured inks, each mineral having a distinctive coloured ink allotted to it. The value of Cu, Au, Ag, Fe, and Insols., and width of each and every sample taken, could thus be seen at a glance.

Stope-assay plans plotted by the chief sampler from his field-notes were kept for each stope taken off, showing height of backs above rail level, date of starting and completion of stoping and sampling operations, also values, widths, and location of samples cut. All assay plans were transferred to tracing cloth, which allowed the various lifts in a stope to be superimposed at any time, and a comparison of values made. Blue prints were taken off as desired for the information of the mine manager as stoping progressed.

The assay values of samples cut underground were found to agree very closely with those obtained in the Brunton-Taylor sample mill from bulk sampling by fractional selection of the trucks of ore raised at shaft, and verified by the smelter returns. The ore could also be broken, hoisted, and sent direct to the smelters on the assay value of the samples obtained from the ore in situ.

In this short description the writer has endeavoured to show the methods adopted by him in sampling low-grade copper–gold deposits, the manner of keeping results, and the uses to which these results were put.

FROTH FLOTATION AT BROKEN HILL.

By C. C. Freeman. B.E.

(Read before the Broken Hill Branch.)

Although great progress has been made in flotation of the Broken Hill silver–lead–zinc ores, no paper dealing with this subject has been presented to the members of the Institute since James Hebbard's valuable contribution in 1913.

Almost every discovery or development in the history of flotation has formed the basis of a patent, and but few experimentalists have overlooked the fact that their investigations might lead to the establishment of a patentable process. This, together with the aftermath of patent litigation, naturally resulted in secrecy being maintained in matters appertaining to the art, and the industry as a whole has consequently suffered considerably. Much valuable time has been wasted through numbers of men repeating work along certain lines, which, unknown to them, had already been thoroughly exhausted by others, whereas a lot of this would have been avoided by a freer interchange of information amongst those directly concerned.

Owing to differences in the ore treated and the various applications of flotation concentration in relation to gravity methods, the flotation problems of the various mines differ considerably. This, together with the secrecy previously referred to, has resulted in the development of numerous systems and machines, most of which would appear, to the casual observer, to comprise separate and distinct processes. The author has endeavoured to show how much these processes have in common with one another, and, at the same time, has tried to convey some general ideas on flotation to those members of the Institute who are not directly associated with this branch of concentration.

[This paper is separately bound, and may be, if so desired, detached complete from this number.]

Many theories have been expounded dealing with the underlying principles which control flotation, and, whilst some of these appear to satisfactorily explain certain of the phenomena, a number of them are of little practical use, and are really only of academic interest. Generally speaking, the men who are directly connected with flotation operations are busily engaged attending to the practical and economic considerations, and have but little time to devote to the purely theoretical aspect, which perforce has to be left to the scientist.

To-day all operators have certain general basic ideas on flotation, but very few would dare to predict the result of treatment of an ore by any flotation method without first having recourse to a laboratory or other testing machine. Undoubtedly, the experimental machine is still the mainstay of the flotation man for all research, investigation, and plant control work.

Although several of the earlier flotation methods employed other principles, almost all the processes which are in use in Broken Hill to-day rely on the carrying power of air or gas bubbles to which the floated material becomes attached, and this paper will only deal with this type of flotation, which is commonly referred to as froth flotation.

Developments in flotation have shown that most of the minerals possess surface properties which allow them to become attached to the air or gas bubbles more or less readily. These properties are not, as was originally believed, confined to those minerals having the metallic-like surface of the sulphide minerals, but are also possessed, in some degree, by most other minerals and many artificially prepared salts.

The flotation art depends on making use of the varying degrees of these properties possessed by different minerals, and, in cases where a separation is required of two minerals possessing the properties to approximately the same extent, by physically or chemically altering these surface properties of one of the minerals, so that one mineral will float more readily than the other.

It may be as well to point out, at this stage, that the terms "preferential," "selective," and "differential" have been used

to describe flotation methods whereby one sulphide mineral is separated from another. In Broken Hill these terms are practically synonymous, but, for convenience, the author has used "preferential" when referring to methods based on chemical alteration of the surfaces of one or more of the sulphide minerals, and "differential" for all the other methods where no definite chemical alteration can be detected. It will be noted that the only difference is that in the former case a preliminary treatment alters the physical conditions of the surface of some of the minerals by bringing about a surface chemical alteration of the mineral itself, and that the actual flotation separation then becomes identical with the "differential" systems. As will be shown, the general principles involved in the differential methods are the same as those used in the older methods that separated the sulphide minerals from gangue minerals, producing what is known as a "collective" or "mixed" float. Certain conditions are necessary to bring about the attachment of sufficient air to an ore-particle to cause the latter to rise to the surface of the liquor. In the case of those minerals—such as some of the sulphides—which most readily become attached to the bubbles, flotation will result when the conditions are developed to only a slight extent, but these conditions must be intensified considerably to bring about the attachment of the air and a less readily floated mineral particle. By controlling the degree of intensification of conditions which bring about this attachment it is possible to separate a mineral which becomes readily attached to the bubbles from another mineral, the surfaces of which have a lower affinity for the same bubbles. Thus, if a mixture of evenly-sized particles of three minerals—(*a*), (*b*), and (*c*)—be subjected to flotation, and if, under the general conditions used, (*a*) possesses surface properties such that the air-bubbles become more readily attached to it than to (*b*), and (*b*) possesses such properties more than (*c*), it will be possible to arrive at a set of flotation conditions whereby (*a*) can be floated away from (*b*) and (*c*). By intensifying these conditions a point will be arrived at when (*b*) can be floated away from (*c*). If these latter conditions are used on the original

mixture the float would contain both (*a*) and (*b*). Thus, the general principles governing the differential flotation and the older collective flotation methods are identical; but, while in the latter case the margin in surface properties in regard to bubble attachment between the least readily-floated sulphide minerals and the dull, oxidized, or gangue minerals is very marked, this difference is often very small in the former case. In collective flotation, therefore, one may vary the flotation intensifying conditions considerably without materially affecting the result, whereas preferential flotation is a much more delicate operation, requiring very careful control in most cases. In view of the fact that the early work in flotation at Broken Hill was directed towards the recovery of blende from mill tailing, de-leaded by gravity concentration methods, and also that the blende required more intense flotation conditions than the other associated sulphide minerals, it was only natural that the conditions developed at that time were sufficiently intense to promote collective flotation.

Flotation ideas thus developed along lines which embraced the liberal use of several of the intensifiers, such as power, heat, acid, and frothing agents. From this it became accepted, at that time, that flotation concentration could only be employed to separate minerals with a metallic-like surface (such as the sulphides) from materials with dull and easily-wetted surfaces. No doubt the fact that so much work was done on more or less weathered dump tailing, in which the relatively low galena content had become sufficiently superficially oxidized to reduce its flotation properties to at least as low as that of the blende, was responsible for the number of years which elapsed between the establishment of the collective and the preferential flotation methods.

Differential Flotation.

As previously stated, the principles involved are identical with those used in the earlier collective flotation methods, and differential results depend on the control and modification of those principles. The methods depend primarily on the fact that, due to the physical properties of the surfaces of minerals,

the bubbles become more readily attached to the surface of some minerals than others, and, by regulating the intensity of the conditions bringing about this attachment, it is possible to form bubbles carrying only the former minerals. The galena in freshly-mined Broken Hill ore possesses the flotative property to a greater extent than the blende, and all the differential flotation methods now used on this field recover the galena in the first float.

Much has been written in technical journals dealing with what may be termed the elements which produce the conditions necessary for the attachment of the mineral particles and the bubbles, but a brief review of these may be of interest. The intensity of the flotation conditions produced is the sum of the effect of each of these elements, and those most commonly used are :—

1. *Air* (or gas such as CO_2 generated from carbonates in the pulp). This is essential in froth flotation as a buoyant to carry the mineral. Within limits, the intensity will vary with the quantity of air introduced into the pulp.

2. *Agitation.*—A certain amount of agitation appears to be essential to all flotation. It has been stated that the main function of agitation is to bring about an intimate admixture and distribution of the oil, and, whilst this is no doubt true to a certain extent, the fact that agitation is necessary when soluble frothing agents are used would indicate that the function of agitation is not limited to the above. Agitation also plays an important part in cleansing the surfaces of the mineral particles, breaking up the air into minute bubbles, and promoting a coalescence between the oiled particles. The agitation need not necessarily be applied in the flotation machine, and, in some cases, the flow of the pulp through grinding machines, launders, and elevators, after the addition of some or all of the flotation reagents, will provide sufficient agitation for the removal of a readily-floated mineral. Owing to the large expenditure of power for agitation, this subject has received a lot of attention, which has resulted in the development of a great variety of flotation machines. The

author's experience, however, has been that, with a given set of conditions, a certain definite expenditure of h.p. is required to produce a certain result, and that frequently a saving in power can be economically effected by increasing some of the other intensifiers or elements.

3. *Frothing agents*, which consist of soluble salts, or, more frequently, oils. The American writers have classified oils as "frothers" and "collectors"—the former containing more or less constituents which are soluble in the flotation circuit, and the latter insoluble oils which coat the sulphide mineral particles. A number of oils, particularly many of the Australian eucalyptus oils, possess the properties of both frothers and collectors. In flotation practice in America great stress seems to be laid on the oil or mixture of oils used; but, whilst very many different oils have been tried in Broken Hill, the eucalyptus and a few coal-tar products are the oils most generally used. American pine oil or pine-tar oil is used to a limited extent in a few cases. The eucalyptus oils used consist mainly of dextrapinene and phellandrene. Some of the oils characterized by being relatively low in phellandrene will, in many cases, give very good results, but may require the addition of a certain amount of a "collecting" oil to make the float sufficiently stable. Usually a number of oils or oil mixtures can be found which will produce identical results, and the final choice in the oil is decided by the cost factor.

4. *Acid* is a potent intensifier. It is universally used in Broken Hill in connection with blende flotation, excepting in cases where the ore is so calcitic that the consumption of acid becomes prohibitive.

5. *Temperature* invariably increases the intensity of the flotation conditions. Owing to the high price of fuel in Broken Hill, heating plant circuits is somewhat expensive, and every endeavour is made to carry out operations at atmospheric temperature. Generally speaking, the end point of a flotation separation is sharper and more clearly defined in hot than in cold circuits.

Within limits, similar results can usually be obtained by increasing one element and correspondingly decreasing another, so as to retain the same intensification of conditions. Thus, two plants working on similar material may obtain similar results, although in one case very little reagent and a lot of power are used, whereas in the other less power but more intensifying reagents are employed.

Given two minerals with an appreciable difference in their flotative properties, a separation can be effected in a fresh-water circuit by applying some or all of the above elements, and, although this can be applied to the separation of galena from blende in many of the freshly-mined Broken Hill ores, the difference in the flotative properties of these minerals is often so small that such a process is rather too delicate and sensitive for ordinary purposes. Lyster discovered that the presence of salts, such as the sulphates of many of the metals in the circuit water, retarded the flotation of the blende, and this principle has, either directly or indirectly, been applied by all the Broken Hill mines which are practising differential flotation. When using this system for differential galena flotation, the blende is subsequently floated from the gangue by increasing the intensity of the flotation conditions by application of acid, heat, oil, or other intensifier. Some of the mines supply the necessary salts to their mill circuits by using the underground mine water, whilst those plants using H_2SO_4 in connection with their flotation operations create an ample supply of salts for differential flotation purposes. The return circuit waters, besides containing these salts, also retain a certain amount of the soluble frothing constituents of the oils used. These conditions are very favourable for differential galena flotation, and advantage was taken of this by the Junction North Company (in their cascading plant), the Central Mine, and the Zinc Corporation (in their zinc concentrator). Very small additions of oil frequently improve galena flotation without raising the blende under these condiitions. Prior to the development of differential flotation it was recognized that if the percentage of these salts in the circuit liquor became too high, blende flotation

was difficult, even in hot, faintly-acid solutions. Thus, T. J. Hoover, in "Concentrating Ores by Flotation," referred to the fact that at the Zinc Corporation plant the blende flotation invariably went off when the quantity of salts in the solution exceeded 3000 gr. per gall.

Reference may be made to the fact that the ore from the Broken Hill lode may be divided into two distinct classes, consisting of sulphide minerals (chiefly galena and blende) in a rhodonitic gangue on the one hand, and sulphide minerals associated with a gangue containing up to 10 % or 12 % of calcite on the other hand. The difference in the flotative properties of the galena and blende is slightly less pronounced in the rhodonitic than in the calcitic class of ore, so that differential flotation is somewhat more easily conducted when dealing with the latter ore ; but in this case several of the methods which depend on the use of acids cannot be so economically applied, on account of the high acid consumption involved.

The circuits necessary for the above type of differential flotation are so cheaply obtained that this method is used whenever possible. In some cases, however, the flotation properties of the galena and blende are so nearly alike that the presence of the salts in the circuit solutions will not sufficiently retard the blende to allow of satisfactory differential results. This occurs with some of the rhodonitic classes of ore, even when freshly mined, and in most of the tailing and slime which has been exposed to weathering. The Bradford SO_2 method is largely used for differential treatment in such cases. The presence of SO_2 in the solutions retards blende flotation to a greater extent than the salts referred to above, and this allows the use of conditions sufficiently intense to float even slightly tarnished galena particles without raising the blende. Subsequent flotation of the blende may be effected by removal of the liquor containing the SO_2, by removal of the SO_2 by aeration or heat, by decomposition of the SO_2 by chemical means, or by further intensification of the flotation conditions by acid and heat. A diversity of opinion exists as to whether it is essential to have salts in solution

to obtain the best results with this process. As acid is used in all Broken Hill plants using the SO_2 process, this is of little account under normal plant conditions, but is mentioned for the benefit of those engaged in laboratory work.

A new method was recently patented by T. H. Palmer, H. V. Seale, and R. D. Nevett, by which results similar to those yielded by the Bradford SO_2 process are obtained. The patentees claim to make a solution of S by boiling tar or other oils in a weak solution of H_2SO_4 in the presence of an excess of powdered S. Whether the sulphur goes into solution as an organic compound, or whether the sulphur removes the fractions of the oil which promote blende flotation, leaving a solution of only the fraction or fractions suitable for galena flotation, is not yet known. Whatever the action may be, the results obtained by the use of this process at the Junction North mine, where the process has displaced the SO_2 process, clearly demonstrate that the process yields the results claimed, and, in view of the fact that subsequent blende flotation can be obtained by only heating the pulp to about 120° F., the process, where applicable, appears to be less costly to operate than the SO_2 process. When operating this process it is necessary to have soluble salts, such as the sulphates of some of the metals, in the circuit water.

The methods outlined above cover most of the differential flotation at present in use in Broken Hill. Many other processes have from time to time been patented, but very few have actually been tried on a working scale. The permanganate method of T. M. Owen and H. V. Seale is claimed to give exceptionally good differential galena results on weathered slime, but, owing to the prohibitive price of this salt during recent years, the process has not been applied commercially. This process appears to embrace some of the anomalies so frequently encountered in flotation, in that, whilst the Bradford process applies SO_2 or other reducing agents, and Lyster uses a circuit containing soluble sulphates, etc., and bichromate has been claimed as producing differential blende flotation, the permanganate (which is an oxidizer) yields a galena float, and the success of the process depends upon using a circuit containing a relatively small quantity of salts in

solution. A soda-ash circuit will give very sharp and clean differential galena results on freshly-mined ore, when only little or no oil is used, and has the advantage that the subsequent flotation of even the coarser blende can be very readily obtained by the use of oil and a salt, such as $CuSO_4$. This process has been successfully applied elsewhere, and would be particularly useful in districts where H_2SO_4 is difficult to procure.

The size of the mineral particles has an important bearing on flotation results, and the larger the particles to be floated the more intense must the conditions be. It therefore follows that, given conditions wherein galena particles have greater flotative properties than blende particles of a similar size—or, in other words, when the intensity of the flotation conditions necessary to produce flotation of the galena are less than those necessary for the flotation of the blende—to float any larger particles of galena that may be present it may be necessary to increase the intensity of the conditions to the extent necessary to cause the finer blende particles to float. When dealing with relatively coarse particles of galena and blende, differential flotation becomes very difficult, and this is probably due to the high specific gravity of the galena compared with that of the blende, which causes the ratio of surface to weight to decrease more rapidly with the former than with the latter mineral as the size of the particles increases. A process such as the Bradford would, to a limited extent, allow a somewhat larger latitude in the relative sizes of the galena and blende particles submitted for differential flotation. Fortunately, very little coarse galena gets past the gravity concentrating machines and reaches the flotation units; in fact, in all products from tables, classifiers, etc., there is a natural tendency for the galena particles to be smaller than the blende particles, and this materially assists differential galena flotation.

Preferential Flotation.

It was early recognized that it was possible to alter the surface of some sulphide minerals so as to reduce their flotative properties and still leave the surface properties of other associated minerals unaltered. Most of the research work, aiming at the

separation by flotation of Broken Hill galena and blende, was directed along these lines prior to the establishment of the Lyster process. A low temperature roast was used in the Horwood process, and a lot of investigation was carried out to endeavour to obtain similar results by chemical means. The blende being a relatively stable mineral compared with the other sulphide minerals occurring in the Broken Hill lode, it naturally followed that efforts were directed towards the alteration of the surface of the galena. Under this heading may be included the processes using oxidizers, such as ferric chloride, in hot acid solutions, and the Bradford acid-salt method, the latter attacking and altering the surfaces of the galena, some of the lead from which passes into solution as a chloride. All these processes are characterized by the blende being floated before the galena, and nearly always result in a zinc concentrate containing relatively high silver values. This is no doubt due partly to the fact that the silver minerals, being readily floated, tend to rise with the first float, and is also partly due to the silver from any soluble silver salts formed by oxidation, etc., being precipitated on the blende. In view of the fact that only small payments are made for silver in the zinc concentrate compared with almost full value for any silver in the lead concentrate, it is of prime importance to recover as much of the silver as possible in the latter product. This phase of the question affected the economic position to such an extent that investigations on these lines were almost abandoned soon after the establishment of the earlier differential galena flotation methods. One may safely state that these preferential methods would be applied to lead–zinc–silver ores only in special circumstances, and then only when differential methods of flotation had failed. With the exception of the Horwood process, none of these methods are now employed at Broken Hill.

Machines Used.

The British mine and the Zinc Corporation still retain the original M.S. type of machine, with separate mixing and spitz compartments, together with the underflow pipes. These machines

give excellent service when a strong, persistent float is produced, and have the advantage of the level of the pulp in each flotation compartment being under control. This control is of great importance when applying an acid treatment to ores containing varying quantities of calcitic materials, such as may be encountered when dealing with a mixture of material from several mines or tailing dumps. In this case an increase or decrease in the quantity of CO_2 evolved reduces or increases the specific gravity of the pulp–gas–air mixture, and, unless the pulp level in each cell can be independently maintained, it is very difficult to control the froth overflow. Apart from the gas factor, the single level or staggered modification of this machine will, on fine material, give equally as good results as will the original type of machine with the underflow pipes. Boxes of the above types, even when reasonably "crowded," do not allow of a very rapid removal of the froth when formed, and are not favoured in cases where a tender froth is produced. The term "crowded" refers to a reduction of the area of the box towards the point at which the froth overflows, so as to increase the amount of froth reaching a given surface area. This results in a quicker removal of the froth, and reduces the relatively dead surface-area away from the overflow lip. The crowding should not be at too flat an angle, and the lip should be on a vertical side of a box rather than over a "crowded" side. The reason for this is that a larger amount of froth reaches the surface close to the crowded side, and this keeps the froth over the whole of the surface moving towards the lip, besides which the pulp at the surface close to a crowded side of a box is more agitated by ebullition than that at a vertical side, so that, if the lip is placed in the latter position, the chances of gangue being carried over mechanically are reduced.

The Central mine has adopted a single-level type of machine, in which the float is taken off the top of the mixing compartment. In this case the necessary air is drawn in below the impellor, and the "still zone," necessary to allow the mineral-charged bubbles to rise to the surface, is produced by baffles arranged above the agitation zone. A modification of this type of box is to be seen

at the British mine, North mine, and the Zinc Corporation differential slime plants. In these instances the air is drawn through hollow over-driven vertical spindles operating more or less shrouded impellors near wearing plates at the bottom of the boxes. The "horizontal" type of box has gained considerable favour of late, especially for slime flotation, and is now used for slime treatment at the Junction North mine and Amalgamated Zinc works, and for all flotation purposes at the Block 10 mine. Several of the other mines are contemplating the installation of this type of machine in place of the existing ones. This machine gives very good results, but the h.p. consumed per ton treated is on the high side. Centrifugal pumps delivering into crowded spitzkasten boxes are still favoured at the Broken Hill Proprietary Company's mine, but, although this type of machine was for a time used to a certain extent by some of the other mines, they have since been replaced by machines of other types. One company uses a modification of the Owen machine for differential slime flotation, but, owing to the exceptionally high power-consumption per ton treated it is questionable if this is the most economical type of machine.

Cascade Boxes or "Pots."—This system, originally introduced by H. V. Seale and W. Shellshear at the Junction North plant, has been applied, for differential flotation, in a portion of the Central mine mill, and for blende flotation at the Amalgamated Zinc plant. Although at first glance this machine would appear to considerably reduce the power necessary for flotation, this is only true to a limited extent. When an ore, prior to reaching the flotation machines, has received almost sufficient agitation to produce flotation, the cascade machine will yield a satisfactory float, but in other cases additional agitation must be provided before passing on to the cascade unit. As in the case of the pneumatic machines, the cascade pots will only give a partial recovery, unless the minerals are sufficiently prepared beforehand. Pneumatic machines have been tried experimentally by a few of the mining companies, but they failed to give results of commercial use.

Scope of Differential Flotation.

With the successful establishment of differential flotation, the opinion was expressed by some that Broken Hill milling practice would sooner or later be revolutionized by a general replacement of gravity concentrating machines (such as jigs, tables, and vanners) by flotation methods. Flotation very quickly displaced the vanners and tables operating on slime and fine mill products, the recovery of the slime galena from which had previously been a bugbear. It must be remembered that the galena which could not be recovered by tabling was in a very fine state of division, and was, therefore, in an ideal state for differential flotation. Owing to the ease with which the coarser galena particles can be recovered by gravity concentration, and to the difficulty of differentially floating such particles, the Broken Hill mills still retain their jigs and Wilfley tables for primary treatment. At the Central mine cascading has replaced all of the primary tables, and the tailing from the former is lower than that previously yielded by the Card table. Rasmus J. Harvey's paper recently read before the I.M.M. shows that the galena in the feed treated is all comparatively fine, and that that recovered from the cascade plant is much finer than that previously recovered by the tables. This means that the galena in the tailing from this section is coarser when cascading is used than when the tables were used; but this galena, passing on to the zinc section, would be recovered more readily in their "de-leading" tables than galena in a finer state of division.

No doubt a certain amount of the work at present done by tables for the recovery of fine galena will ultimately be performed by flotation, and, in view of the fact that in an hydraulically classified product the galena particles are smaller than the blende particles, close classification should materially assist in bringing this about. On the other hand, jigs and tables are not very expensive machines to run; they make good recoveries of the coarser galena in a concentrate which contains less blende than an equivalent flotation product, and the concentrates pro-

duced by the former methods are more easily drained and handled than those produced by the latter. In the light of present knowledge the author is strongly of the opinion that the major portion of the gravity concentration now practised in the Broken Hill mills will not be replaced by flotation methods.

The successful application of collective flotation for separation of the sulphide lead–zinc–silver minerals from gangue has been responsible for a revival of investigations of leaching methods for the recovery of lead and silver. A great amount of research work with various solvents was carried out at the Broken Hill Proprietary Company's mine prior to 1900, but, owing to high operating costs, such processes could not be economically applied to the relatively low-grade mill products. Now that it is possible to obtain high-grade mixed sulphide products containing very little gangue, the possibilities of these methods have been greatly increased. The solution of the galena never did present any serious difficulties, and it is now claimed that very high extractions of silver can be obtained in the presence of unaltered blende. These methods, yielding a much more complete separation of the lead and silver from the blende than that obtained by any of the known differential or preferential flotation systems, will, with further development, probably be able to compete with flotation methods in many instances. The high operating costs of the solvent methods will, however, to a certain extent offset the increased lead and silver recoveries, and the scope for such systems can only be determined by economic results. Undoubtedly there is room for both systems in Broken Hill, and the solvent methods should be of especial advantage for treating slime mixed concentrate or slime middling, which products are usually rich in silver.

$CuSO_4$.

Reference must be made to this salt, the use of which has considerably increased during recent years. Although originally specified in a patent of Bradford's, it was not, so far as the author is aware, used commercially in Broken Hill until 1916. Small qantities of copper or any of the highly electro-negative metals.

such as Au, Pt, Ag, and Hg, are rapidly precipitated from solution when added to a pulp containing galena and/or blende, and, whilst in the case of freshly-broken galena no increase in the flotative properties is noticeable, an appreciable enhancement in the flotative properties of the blende is produced. This enhancement is usually sufficient to bring about the flotation of very fine blende particles in neutral or alkaline circuits under conditions suitable for differential galena flotation, but not sufficient to promote flotation of coarse blende without the addition of some strong intensifier, such as acid. It has been found, however, that the addition of about 0.1 lb. of Cu in a soluble form to an ore containing about 14 % Zn will allow the blende to float with less acid than would otherwise be required. This is of special value when treating calcitic ore, and the practice at the zinc concentrator of the Zinc Corporation may be instanced, where tailings which would require 60–70 lb. of acid per ton under ordinary mineral separation conditions needs only 25 lb. of acid to promote blende flotation after the addition of about $\frac{1}{2}$ lb. of $CuSO_4$–$5H_2O$ per ton. All the copper added is precipitated and removed with the blende, so that the return circuits are suitable for differential galena flotation, if desired. Many of the parts of the earlier laboratory flotation machines were constructed of copper or alloys containing copper, and small quantities of this metal passing into solution were no doubt frequently responsible for apparent anomalies between results obtained by different experimentalists. This factor probably retarded the discovery of many of the differential galena-flotation methods.

Flotation of Oxidized Ores.

So far, little has been done on a commercial scale in Broken Hill in this respect, but at least two mines have in view the recovery of oxidized lead values from dump material. As far as the author knows, the systems proposed include the superficial sulphiding (by H_2S, Na_2S, or similar reagent) of the oxidized galena particles, and the subsequent flotation of the same after the recovery of unoxidized galena and blende by ordinary

methods. This method might be classed as a preferential method. It may be noted that the blende has higher flotative properties than the superficially re-sulphided lead minerals, so that the "lead" float is the last to be taken off. Unless there is sufficient unoxidized galena to allow a primary float of this to be made, it appears as if there would be a tendency for a lot of the silver to find its way into the blende product.

Conclusion.

The author has endeavoured to explain some of the phases of froth flotation, especially as applied to Broken Hill ores, from a practical point of view. Those who are closely associated with flotation work in Broken Hill will find that this paper contains nothing that is "new," but, as previously stated, any new discoveries in flotation have, to date, always been first described and published in patent specifications. Of recent years the practical side of flotation knowledge has made great strides, but many phenomena have not yet been satisfactorily explained. From time to time numerous theories have been advanced to try and explain certain flotation phenomena, but very rarely, if ever, has a successful flotation process been evolved except by flotation experiments on a "hit or miss" principle.

The author is indebted to those flotation men in Broken Hill who are at all times willing to freely discuss flotation matters, and trusts that before long the staffs on all of the mines will realize that a free interchange of ideas on such matters is to the material benefit of all those directly concerned, and also of benefit to the industry generally.

DISCUSSION.

Mr. H. J. Robertson asked whether in using copper sulphate, it would be necessary to use impellers of material other than iron, because of the fact that copper sulphate was more readily precipitated by iron.

Mr. C. C. Freeman, in reply, stated that he thought there need be no worry over the use of iron impellers. At the Zinc Corporation iron impellers are used and the analyses of the concentrate always showed that the copper had gone into the float.

Mr. E. T. Henderson drew attention to the statement attributed to Mr. Hoover that 3000 gr. of salts per gallon in solution affected the recovery of zinc sulphide. At the plant where he was engaged they calculated the salts in parts per million, and their circuits ran up to 90,000 parts per million. He had reason to think that the higher they were—within certain limits—the better. They always tried to keep a large amount of salts in solution, chiefly soda sulphate, salts of iron, and sodium chloride. In regard to the silver recovery in the Bradford salt-sulphuric process, if was undoubted that with ore that had been crushed and rolled for a mill product, by the use of the salt-sulphuric process a larger amount of silver would follow the blende, than with a process in which the lead was first floated. On the other hand, if the crude ore was crushed in the laboratory and no mineral oil allowed to come into contact with it, then he thought that the blende would carry no more silver than that obtained by any other method. He had had as low as 3 oz. Ag. per ton in zinc concentrate by this process from a crude ore crushed under these conditions, and 6 oz. had been quite common. He had found that mineral oil destroyed the flotation. The salt-sulphuric process had never been tried on a large scale in Broken Hill but he had made 30-lb. tests and obtained good results.

Mr. Freeman said that he merely mentioned Mr. Hoover's statement to show that the question of the salts had been recognised as early as 1911 or 1912. At the Zinc Corporation they now had no trouble with salts in the quantities formed in the circuit solutions. Regarding silver recoveries in the absence of oil, that was a new thing to him.

Mr. Henderson pointed out that he referred exclusively to mineral oil. Oils such as eucalyptus were not detrimental.

Mr. Andrew Fairweather asked had it been definitely discovered how the silver existed in the sulphide ore. Both Messrs.

Freeman and Henderson had something to say on that point, but he wished to know whether the silver existed separately from either the blende or galena in the states of division present in flotation methods.

Mr. Freeman thought that at present they relied mainly on guess work in regard to the state in which the silver occurred, as it was very difficult with the ordinary run of ore containing a few ounces of silver per ton, to say how that silver existed.

Mr. Ralph D. Nevett said that in Mr. Freeman's paper the question of air was referred to. He understood that meant atomised air, as a float could not be obtained unless the air injected into the pulp was atomised. In regard to pinene oil, the experience of the Junction North Company was that 60 % phellandrene oil would give better results than any pinene oil. With regard to the SO_2 process and the question of whether salts in solution had any effect, they found the Bradford-Hypo process would not work in the laboratory without there being salts in solution. They could not work the plant with fresh water and get selective results. In connection with the question of silver in the ore, he had been told by Mr. Palmer, who had done a good deal of research work, that the Ag. existed as a silver sulphide—not chemically combined with either galena or blende.

Mr. Fairweather asked if it would be as a separate or pure particle at the point of division ?

Mr. Nevett said that with crushed ore the silver was quite separate.

Mr. Walter G. A. Smith inquired if silver was a separate mineral, which seemed to be the fact when it could be thrown either into the blende or the galena—did it not suggest the possibility of deadening either the galena or the blende so as to be able to separate the silver ?

Mr. Nevett said the Junction North Company tried to do that but did not succeed. He thought it could be done, even though they had not yet succeeded.

Mr. Freeman in reply to Mr. Nevett's remarks said that he intended that the air was atomised ; his comments in the paper

were meant as a brief review of the elements. Concerning the pinene and phellandrene, his company had for a long time been looking for a method of estimating the phellandrene; their experience was that they could only get qualitative tests from which a rough idea was obtained of what proportion of phellandrene was in an oil and their experience was that they could in many instances obtain good results by using eucalyptus oil containing but little phellandrene. These results had frequently equalled the results obtained with high phellandrene oils. At the same time, flotation requirements differ so much that he would not like to lay down any general rule. Prior to the influenza epidemic there was no trouble in getting a good class of eucalyptus oil, but latterly the manufacturers had apparently been re-distilling the crude oils for recovery of cineol and the more valuable fractions and at the present time it was very difficult to get any two oils alike.

Mr. W. J. McBride asked whether the researches of Dr. Langmuir of the G.E. Company's laboratory at Schenectady, into ore flotation had come under Mr. Freeman's notice.

Mr. Freeman replied that he had not heard of them.

Mr. McBride mentioned that the matter came under discussion at Salt Lake City, and a line of research was outlined, which, starting with an investigation of the nature of oil films on water and the apparently capricious attachment of sulphide particles to these oil films, had led to the study of the behaviour of the mercaptans and to the discovery that the flotation of any particular artificially prepared sulphides could be controlled by a definite mercaptan. The researches were interrupted by the war, but doubtless were being continued with natural sulphides. He mentioned this as indicating that the "hit or miss" methods were giving way to scientific attempts to explain the laws governing flotation. He did not know how the mercaptans were being prepared.

Mr. Freeman referring to the "hit or miss" principle, said that in Broken Hill they were able to float minerals, but they had only arrived at their present stage by following these methods.

Mr. Fairweather thought that it would be better if work were carried out at the dictate of scientific reasoning.

Mr. Freeman considered the question of mercaptans was rather interesting in connection with the recent "sulphur solution" patent. The mercaptans were one of the few salts that might be formed.

Mr. McBride explained that the line of reasoning could be condensed as follows—in a volume of oil of molecular thickness on water the relative position of the oil molecule to the water surface is constant, *i.e.* the unwettable side is uppermost, and naturally is crowded with a volume of unwettable sulphide if present. By controlling the structure of the sulphur group on the mercaptan, the nature of the sulphide particles which are to be wetted or picked up by the mercaptan could be also controlled.

Mr. Henderson said, in reference to the question of the SO_2 process working in fresh water, he had never tried hypo in condensed water in Broken Hill, but had tried the SO_2 on a Tasmanian ore in condensed water, in which case it worked well. By the time SO_2 had been passed through condensed water containing sulphide, it was no longer fresh water, so that it really did not solve that problem. The process certainly could be worked with a very small proportion of sulphites in the water. Regarding the silver in the ore, he had never looked for it with a microscope, but firmly believed that it was free from the other sulphide minerals for the reason that his Company was dealing with very oxidised slimes and they found that the more oxide of lead the slimes contained, the higher were the silver values of the concentrates, whereas if the lead and silver were combined, these metals would exist as oxidised salts. The silver was a free sulphide in itself and floated quite as readily, if not more readily, than galena.

Mr. Fairweather drew attention to the suggestion in the latter part of Mr. Freeman's paper of the possibility of methods for the extraction of the silver and lead by solution. He wished to know what Mr. Freeman had in his mind when he made that reference.

Mr. Freeman said that at the present time there were several processes in course of development, the details of which had not yet been published. In these processes they treated a mixed concentrate. He thought these methods would always be pretty costly, and mentioned they were still only in the experimental stage.

Mr. Fairweather asked whether it was not possible for the smelters to make such improvements in their methods as to be able to separate the lead from the zinc, or whether the metallurgists will be able to do that in the treatment plant.

Mr. Freeman replied that smelting, during the last four or five years, had made great advances on the question of dealing with the zinc, in lead ores and concentrates. The next few years would probably witness great strides in the treatment of these mixed products by both pyro- and hydro-metallurgical methods.

Mr. Fairweather thought, viewing the problem as as a layman, that flotation would never make great strides until the science of the business was better known. He could not conceive of the perfection of a process merely by rule of thumb methods. Also, viewing it as a layman, if smelting were more scientific than flotation, then he thought that smelting would take on the problem of separating the lead from the zinc rather than it being done by flotation. He was curious to know whether the metallurgists on the Broken Hill field had any great difficulty in repeating in the plant the results they had obtained in the laboratory.

Mr. Freeman said that from his experience there was no difficulty in obtaining in the plant the results obtained in the laboratory. In fact there was a better chance of getting good results with the working unit than there was with a small laboratory machine. The reason was that an ordinary laboratory machine was a "charge" machine which did not permit of any fine adjustments, whereas with a running plant adjustments could be gradually worked up, which permitted better results.

Mr. Nevett indicated that his experience was the same as Mr. Freeman's.

WHAT IS THE MATTER WITH AUSTRALIAN MINING?

By F. Danvers Power.

There are certain facts that the mining industry in Australia is faced with at the present moment which may be accepted as axioms.

The industry is at a low ebb, as evidenced by statistics.

Metals form the basis of all modern industries, and are necessary for the welfare of Australia.

Mining is a wasting asset. Every ton of ore extracted is one ton less which cannot be made good, and it should be our duty to get as much profit from that ore as possible, otherwise there is a permanent loss to the country.

The metal market cannot be controlled by Australia; it is more or less an international matter.

Australia has not been thoroughly prospected.

There are no mines being developed that are likely to replace those which are being depleted.

Our mining engineers are as capable as those in other parts of the world, and have made good where they have been given a chance.

There is no one cause for the present depression; there are several, more or less interwoven. Of course, the war has had an adverse effect, but that has only dislocated things temporarily; it upset our markets, influenced the price of metals, and affected the labour market and cost of stores. Labour troubles made their appearance before the wave of unrest swept over the world. The cause of labour discontent must be investigated, and if possible removed. As each industry has its own problems, miners must inquire into their special problems, as there is no sovereign remedy that will suit all cases.

It is obvious that we cannot mine ore if we do not know where it is; therefore, the first thing is to discover workable deposits.

[This paper is separately bound, and may be, if so desired, detached complete from this number.]

Geologists are often asked how it is that they seldom if ever find valuable ore deposits, while prospectors who are not scientifically trained do. We must bear in mind that the prospector is a pioneer, while the geologist is not, as a rule, neither does he lay himself out to search for mineral deposits; he generally tries to interpret the geology of a district already more or less opened up. The fact that he does not find many deposits is not that he could not, but that he seldom undertakes that class of work. Anyhow, there are (or used to be) many more prospectors out in the field than geologists, so naturally the chances were in favour of the former, especially as he goes in advance of civilization, so gets the first opportunity. However, there are ample instances of trained geologists who have made discoveries of valuable deposits when they have sought for them. Geology is not an exact science, and no geologist is infallible. Strange as it may seem, many valuable discoveries have been made by accident by people who were neither geologists nor prospectors.

Unfortunately, the old-time prospector of the Philosopher Smith type, who discovered the Mount Bischoff tin mine in Tasmania, is becoming past history. The deposits that are easily worked from the first, with but little capital, do not seem to be coming to the fore. The large low-grade deposits, formerly looked on as little more than mineralized rock, form the mines of to-day and to-morrow, made possible by working on a large scale, by modern methods, with improved machinery and high explosives. Such deposits do not appeal to the old-time prospector. He cannot work them himself, so has to sell out to those with more money than he has, and, forgetting he is selling an unproved deposit, which, if rich and large enough, will require years to open out, and a large expenditure of money to develop and equip, considers he is being swindled by the capitalist, so prefers to leave such properties alone. If individuals will not carry out this class of work, then syndicates, companies, or even the Government must do so, unless we are to allow the mineral assets of the country to lie dormant while our industries depend on imported metals, which is not a healthy condition for any country.

Australia has only been sporadically prospected. We do not know what wealth we have hidden underfoot. To discover this, the country must be systematically prospected under the supervision of properly trained mining geologists. If this work is carried out by private enterprise, then the Government should make it worth the while of individuals by framing suitable laws. If the Government carries out this work, no better way could be found to spend the prospecting vote, for the money of the taxpayer would be better spent in that manner than by doling it out in order to artificially support forlorn hopes. This is a matter that the Australasian Institute of Mining and Metallurgy, as representing the best mining talent in Australasia, should take up.

At one time a geologist took more interest in rocks and fossils than in valuable mineral deposits, but the utilitarian point of view has come to the front, and now we have mining geologists who specialize on useful mineral deposits.

The old Cornish miner's statements of "Where it is there it is" and "You can't see further than a pick's point into the ground," though still holding good so far as the words are concerned, the inference implied requires modification, for facts that have accumulated during recent years enable competent mining geologists to come to conclusions which were impossible in the last generation. Although we still find some men who, in their ignorance, will not admit the application of scientific knowledge, there are others that do, and the fact that large companies are glad to avail themselves of the services of such specialists, and benefit by them, should be sufficient answer to the former. If the Government undertook to systematically prospect the country it could then charge a higher royalty to those who worked anything it discovered, and so recoup its prospecting expenditure.

There is no doubt that the gambling spirit in man has encouraged many to put money into mining. Most of those who take up mining shares know little or nothing about mining, and have no desire to do so. Their chief idea is not to make money out of mines so much as out of the pockets of those whose judgment is inferior, or who are prepared to take greater risk by buying their shares at an enhanced value.

Much as it may go against the grain of those who prefer to look on their calling as an industry rather than as an excuse for gambling, it must be admitted that had the means for opening up mineral properties not been supplied by those with the gambling spirit, many of our mines would not be in existence at the present day. As shares frequently change from hand to hand, it is not often that one individual stands the whole loss of a fall in price. According to some people who like to "talk big," their losses in mining are enormous; but when you come down to bed-rock these alleged losses are frequently found to be on paper only, and are reckoned on what they might have made had they bought in at the lowest price and sold out at the highest, and that the highest kept up till they had sold out all their interests.

Though some people are prepared to put their money into prospects in the hope of making a coup to more than cover what they have spent on failures, there are others who prefer to invest in a proved mine. But before a mine can be proved it has to be discovered and developed. It may not be considered the province of a Government to spend the taxpayers' money in developing and working mines, but money would be well spent in discovering the existence of valuable mineral deposits to be leased to others, for by so doing not only is a valuable national asset made available, but its extraction finds employment for miners and those dependent on them. We must not overlook the fact that the great fillip which brought men and money to colonize Australia was due to our mineral wealth. If the discovery of minerals is to be left to private enterprise, then the terms should be made as favourable as possible on account of the risk incurred. One drawback to private enterprise undertaking prospecting and development work is the labour conditions involved. Naturally, one does not want to sink money in a property in which he is likely to lose the results of his enterprise; at the same time, the country does not want its assets locked up indefinitely. One might say that an enterprise should not be undertaken if it is not in a position to be carried out. Anyone who has had much to do with mining knows that it is easier to

get money to develop something that exists than to search for something that is an unknown quantity. Counting on this, many paying concerns have been started with insufficient capital, in the hope that when its nature was proved more capital would be forthcoming. Cases are also known when men on strike have tried to use the labour conditions to force the mine-owners to accede to their demands. The motive that caused labour conditions to be inserted in mine leases is all right, but the method of carrying out that motive is open to question. Should labour be the unit employed, or would it be fairer to include other costs in connection with mines, especially those to do with work such as shaft-sinking, drives, and crosscuts that cannot be removed and sold elsewhere? A large mine generally requires expensive machinery that often has to be specially constructed, and cannot find a ready purchaser when discarded. After all, what is the object of mining? To find employment for miners, or to wrest a profit from the rocks? Those who put their money into mining do not do so as a matter of charity; they have a right to expect their capital back with a fair interest, which will vary with the risk run. If a mine is run solely with the object of making employment for men and those who trade with them, then the public will prefer to direct their savings in some other channel, and this is exactly what many people who can earn money above their actual present needs are doing.

Those who advocate that the Government should own and run all industries overlook the fact that the men who are qualified to be bosses now are the same men who would be bosses if the Government took over the various industries on behalf of the people. Human nature is the same, whether applied to private individuals or the Government. The actual ownership is merely a side issue; it is the conditions that count. Dissatisfaction is not peculiar to privately owned enterprises, for strikes are by no means unknown in Government-owned mines and railways. Although a monopoly owned by the Government should be better organized and worked cheaper than several industries of the same nature owned by several parties, experience to date goes to show

that the motive for hard or even fair work is lacking; in other words, the average individual will not work so well for his country as he will for himself, and any advantage obtained by the monopoly is swamped by the inferior work of the individual. If, then, the time is not ripe for Australia to adopt Utopian methods, let the Government do the next best thing so far as mining is concerned, and allow liberal areas and conditions to those who are prepared to prospect and work systematically.

From time to time it becomes necessary to conform to circumstances and make changes. The present would seem to be one of the turning points. In the early days of the Ballarat gold diggings a miner's right allowed a man to take up 8 ft. by 8 ft. as a claim. As the rich one-man shallow deposits became worked out, larger areas had to be granted, which required the co-operation of several men with capital to open up and provide with machinery. The day of rich deposits is passing, or past, so terms must be granted that will encourage those with money to develop and work large low-grade deposits, if mining in Australia is to continue.

The two main objections that have been raised by the few who are willing to risk their money in Australian mining are the uncertainty of tenure owing to labour conditions and the uncertainty of the attitude labour will assume.

Looking back in history, three years seems to be the time necessary for a country to settle down after a great upheaval. At present it does not look as if this period was likely to be reduced in our case. Conditions of labour are looked at from a different angle to what they were before the war. One thing is certain: we will not return to the old conditions. Many companies have for years past tried to better the conditions of their employes, but the employes too often look on these advances with suspicion; their first thought is, "What is the boss getting at?" and instead of helping to put the mine-owner in a position to pay higher wages by producing more, they make it impossible by going slow and refusing to play the game. How this has reflected on the men has been illustrated in the closing down of

English-owned mines on the Etheridge goldfield, Queensland, and the engineering works of the late Sir P. N. Russell, in Sydney

The extremist, whether employer or employed, must eventually give place to one with moderate views; and unfairness to justice; but in the meanwhile the extremist is doing his level best to ruin the mining industry. Some people live in the past, and think of former acts in the light of existing conditions, while others live in the future, and have ideals impossible to eventuate at the present time.

Now, more than at any other time in the history of Australia, do we require level-headed men to take matters in hand. Mining engineers, on account of their varied experiences, have proved themselves good organizers during the recent war; surely it is up to them to set their own house in order. It is to be hoped that our Institute will appoint various committees to look thoroughly into these matters and take steps to place the Australian mining industry on a proper basis.

DISCUSSION.

Professor E. W. Skeats said Mr. Power's paper touched on many important points. He would like to refer to one statement particularly—viz., "that geologists had seldom, if ever, found valuable ore deposits." He pointed out that in the United States and Canada very definite and recognized schools of mining geologists were permanently attached to big mining enterprises, railway companies, water supplies, and other industries. The position in Australia in that respect was lamentable. He had tried to train economic geologists, but had received no encouragement. None of the big mining corporations, except Mount Morgan, had taken up that work. He referred to the valuable work done by Dr. Stillwell on the Bendigo field on the localization of gold-bearing shoots and to the fact that the same scientist was now doing research work on the Broken Hill field. He (Professor Skeats) was certain that if the same encouragement

were given in Australia, as in the United States of America and Canada, it would pay the companies handsomely, and waste of money would, to a large extent, be prevented. The time was ripe for companies in Australia to reconsider their attitude. He suggested that the Institute and the various corporations should take this matter up. As an instance of what was done in America, he said that one company alone employed forty economic geologists.

Mr. Wm. Poole said that some of the present State Advisory Committees of the Council of Science and Industry did not contain any member who, by training or association, had any personal knowledge of the mineral industry which was so important and vital to the well-being of the Commonwealth. This is the position of affairs in New South Wales, a State whose mining interests—both coal and metalliferous—are pre-eminent in the Commonwealth. As a matter of fact, the composition of the Advisory Committee is very unsatisfactory. Until very recently, when Mr. A. J. Gibson, late Professor of Engineering of Queensland University, took up his residence in New South Wales, the above Committee did not contain a single member representative of the mining, manufacturing, and engineering industries. This unsatisfactory position also existed in some other States. This was a matter in which the Institute could take action with great advantage to the mineral industry. He therefore moved—"That it be a recommendation to the Council that it consider the question of approaching the Institute of Science and Industry to ensure that the Mining Industry is represented on the Advisory Councils of each State and on Standardization Committees." The Advisory Councils referred to are those which are to be established under the Institute of Science and Industry Bill then before the Commonwealth Parliament; but as the passing of the Bill into law seems to be indefinitely postponed, it would also be advisable to take similar action in connection with the existing State Committees of Advice of the Council of Science and Industry.

The motion was seconded by Mr. C. A. Hack and declared carried.

Mr. J. M. Bridge said that a geological survey of Australia should be taken in hand. He considered this absolutely necessary as an aid to prospecting.

Mr. C. F. Courtney pointed out that in the United States of America corporations were encouraged to take up large tracts of country, but no such encouragement was given in Australia.

Mr. Poole said the method of appointing members of the Geological Survey staffs and the policy of conducting the Geological Surveys needed serious consideration and revision in several of the States. Most of the men appointed to the Geological Survey staff of New South Wales prior to 1896 possessed a systematic academical training in geology and collateral science. The Public Service Commission of New South Wales was appointed in 1896, and early introduced a scheme in which admission to the professional service—*i.e.*, engineering, geology, etc.—should be as probationary cadet trainees upon a small pittance of salary. University graduates of undoubtedly high training and ability were to be put on the same footing as a lad coming direct from school. The result has been that, although the University of Sydney, under the training of Professor David and other members of staff, has turned out graduates who have done conspicuously fine geological work throughout Australasia, nevertheless not one such man has entered the New South Wales Geological Survey. He should, however, in fairness state that many of those who entered as raw probationers have become eminent as field geologists, but this was a tribute to personality, determination, and ability of the individual rather than to a very defective system. He undertsood that a somewhat similar state of affairs existed in Victoria. He thought the Institute should approach the Governments of the various States and urge the employment of men of good academical training. Such a training should be a pre-requisite to entering the professional service. The policy, or want of policy, in conducting the Geological Surveys in the various States was also a matter requiring serious consideration. Many years ago a systematic geological survey of Victoria was undertaken. This valuable work was, for political reasons,

suddenly abandoned and the staff disbanded. The principal coalfields of New South Wales and southern Queensland have been more or less systematically examined and the results made available to the public, but in other respects it has been mostly the custom throughout the Commonwealth merely to examine those fields or single deposits where difficulties threaten the existence or establishment of profitable mining operations. So long as the field or locality was prospering it was seldom that anything was done, except perhaps a hurried "inspection of curiosity." Many of the geological surveys of well-known fields were *pre-mortem* examinations to ascertain if life could be prolonged. Charters Towers—which, after Kalgoorlie and Bendigo, had produced more gold than any other field in Australia—was not examined underground until nearly all the well-known mines were quite defunct, or at least had ceased to be active producers. The same thing in a lesser degree occurred at Gympie. The Cobar field was not systematically examined until the industry was in a very critical condition. Broken Hill was examined over 20 years ago during its juvenile prosperity, but it was apparently studiously avoided until quite recently, when its future continuance as a large centre became a serious industrial and political question. The foregoing are outstanding examples of a pernicious policy of *laissez-faire* which very widely exists. The Institute would confer a public benefit in firmly and insistently urging upon the various States the necessity of systematic examination of their mineral deposits, modes of occurrence, and geological perplexities. Mining companies, with very few exceptions, have not had their properties geologically examined in a systematic manner. The Mount Morgan Co., quite early in the life of the mine, deputed one of its staff to examine the geological formation, and at a later date appointed a staff of trained men to minutely examine and map the various geological features of their properties. Some of the Kalgoorlie mines have had private systematic geological examinations. The lack of appreciation of the value of practical geology has led many companies to waste their resources in useless work or to overlook valuable features. All material which was

not ore was classed as "mullock" at Broken Hill. Garnet sandstone was not considered to be lode material until Mr. J. C. Moulden at the Junction mine drove through a body of it and developed valuable sulphide ore, the existence of which was not suspected by previous management.

Professor Skeats said that in the Geological Surveys of Victoria and New South Wales only untrained men were getting experience as juniors. He strongly urged that those who entered these survey departments should be all trained men. He referred to the miserable inducements given by mining companies in the past to University-trained men. The position was, however, he was glad to say, now being changed, and the companies were offering bursaries to students in mining and metallurgy. He wished once more to urge the creation of a small school of economic geologists in Australia.

Mr. H. A. Evans suggested that the Universities were not sufficiently in touch with the companies, as was the case in America.

Mr. Poole was of opinion that the Department of Engineering in the University of Sydney should be made a separate Faculty,* and that the Faculty should, as at Melbourne, include engineers and metallurgists in practice, and in this way keep the University in touch with the applied side of the profession.

* It has since been made a separate Faculty.

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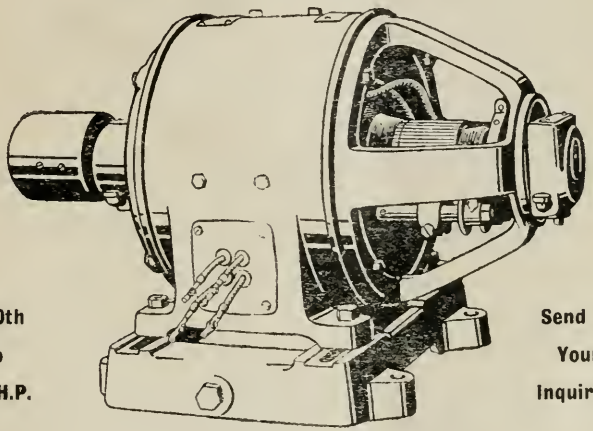

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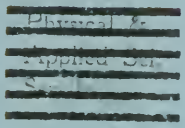

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